6

Evaluating Options From a Statewide Perspective

A main objective of this *California Water Plan* update is evaluating, at an appraisal level of detail, how California's water supply reliability needs could be met through 2020. This chapter outlines the process used to put together the conceptual evaluation and evaluates water management options that are statewide in scope. A brief discussion of methods available to local agencies for financing water management options is also provided.

The planning process includes developing regional water management evaluations for each of the State's ten major hydrologic regions, and integrating those results with statewide water management options to form a summary for the entire State. Development of regional water management evaluations is covered in Chapters 7-9.

Statewide water management options include demand reduction measures that many water agencies are expected to implement, and large-scale water supply augmentation measures that would provide supply to multiple beneficiaries in more than one hydrologic region. For example, a large offstream storage reservoir studied under CALFED's Bay-Delta program is considered a statewide option. A small reservoir project being studied by a local agency to provide benefits only to its service area is not a statewide option. Such local projects are covered in Chapters 7-9. This chapter opens by presenting a balance between California's water supplies and its water use, illustrating the shortages that would occur if no new water management facilities or programs were developed.

Sources of water supply must be identified to meet the needs of California's growing population. Chapters 6-9 discuss potential future water management options.

TABLE 6-1

California Water Budget with Existing Facilities and Programs (maf)

	1995		*2020*	
	Average	*Drought*	*Average*	*Drought*
Water Use				
Urban	8.8	9.0	12.0	12.4
Agricultural	33.8	34.5	31.5	32.3
Environmental	36.9	21.2	37.0	21.3
Total	**79.5**	**64.7**	**80.5**	**66.0**
Supplies				
Surface Water	65.1	43.5	65.0	43.4
Groundwater	12.5	15.8	12.7	16.0
Recycled & Desalted	0.3	0.3	0.4	0.4
Total	**77.9**	**59.6**	**78.1**	**59.8**
Shortage	**1.6**	**5.1**	**2.4**	**6.2**

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Statewide Water Budget

The water supply and water use information discussed in Chapters 3 and 4 and summarized in Tables 3-3, 4-26, and 4-27 is combined into the statewide applied water budget with existing facilities and programs shown in Table 6-1. Regional water budgets with existing facilities and programs are shown in Appendix 6A. The shortages shown in Table 6-1 reflect the Bulletin's assumption that groundwater overdraft is not available as a supply.

The average water year shortages at 1995 and 2020 levels illustrate the need to develop new facilities and programs to improve California's water supply reliability. Californians are facing water shortages now, and will face them in the future. As Californians experienced in 1991 and 1992, drought year shortages are large. Urban water users faced cutbacks in supply and mandatory rationing, some small rural communities saw their wells go dry, agricultural lands were fallowed, and environmental water supplies were reduced. By 2020, without additional facilities and programs, these conditions will worsen, reflecting California's forecasted population increase. Appendix 6B shows forecasted shortages by hydrologic region, assuming that no new facilities or programs were implemented.

The following section describes the planning process used in Bulletin 160-98 to evaluate actions that would reduce the State's future water shortages.

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The Bulletin 160-98 Planning Process

The process used to evaluate ways to meet California's future water needs drew upon, at an appraisal level of detail, techniques of integrated resources planning. IRP evaluates water management options—both demand reduction options and supply augmentation options—against a fixed set of criteria and ranks the options based on costs and other factors. Although the IRP process includes economic evaluations, it also incorporates environmental, institutional, and social considerations which cannot be expressed easily in monetary terms.

The development of likely regional water management options used information prepared by local agencies. The regional water management options evaluations are not intended to replace local planning efforts, but to complement them, by showing the relationships among regional water supplies and water needs and the statewide perspective. Local water management options form the basis of the regional summaries which are combined into the statewide options evaluation. Figure 6-1 is an index map showing how the regional summaries are organized in Chapters 7-9.

FIGURE 6-1

Index to Regional Chapters

Initial Screening Criteria

The criteria used for initial screening of water management options were:

- ***Engineering***—an option was deferred from further evaluation if it was heavily dependent on the development of technologies not currently in use, it used inappropriate technologies given the regional characteristics (desalting in the North Lahontan Region), or it did not provide new water (water recycling in the Central Valley).
- ***Economic***—an option was deferred from further evaluation if its cost estimates (including environmental mitigation costs) were extraordinarily high given the region's characteristics.
- ***Environmental***—an option was deferred from further evaluation if it had potentially significant unmitigable environmental impacts or involved use of waterways designated as wild and scenic.
- ***Institutional/Legal***—an option was deferred from further evaluation if it had potentially unresolvable water rights conflicts or conflicts with existing statutes.
- ***Social/Third Party***—an option was deferred from further evaluation if it had extraordinary socioeconomic impacts, either in the water source or water use areas.
- ***Health***—an option was deferred from further evaluation if it would violate current health regulations or would pose significant health threats.

Major Steps in Planning Process

Major steps involved in the Bulletin 160-98 water management options evaluation process included:

- Identify water demands and existing water supplies on a regional basis.
- Compile lists of regional and statewide water management options.
- Use initial evaluation criteria to either retain or defer options from further evaluation. For options retained for further evaluation, group some by categories and evaluate others individually.
- Identify characteristics of options or option categories, including costs, potential demand reduction or supply augmentation, environmental considerations, and significant institutional issues.
- Evaluate each regional option or category of options in light of identified regional characteristics using criteria established for this Bulletin. If local agencies have performed their own evaluation, review and compare their evaluation criteria with those used for the Bulletin.
- Evaluate statewide water management options.
- Develop tabulation of likely regional water management options.
- Develop a statewide options evaluation by integrating the regional results.

The first step in evaluating regional water management options was to prepare applied water budgets for the study areas to identify the magnitude of potential water shortages for average and drought year conditions. In addition to identifying shortages, other water supply reliability issues in the region were reviewed. Once the shortages were identified, a list of local water management options was prepared. Where possible, basic characteristics of these options (yields, costs, significant environmental or institutional concerns) were identified.

After identifying options, they were compared with the initial screening criteria shown in the sidebar. For options deferred from further evaluation, the major reasons for deferral were given. Options retained for further evaluation were placed into the following categories:

- Conservation (urban and agricultural)
- Modifications to existing reservoirs/operations
- New reservoirs/conveyance facilities
- Groundwater/conjunctive use
- Water marketing
- Water recycling
- Desalting (brackish groundwater and seawater)
- Other local options
- Statewide options

Because each of these categories may contain many individual options, some options within each category were further combined into groups based upon their estimated costs. For example, water recycling projects costing less than $500/af were grouped into one category. Options were evaluated and scored against the set of fixed criteria shown in the sidebar.

The Bulletin 160-98 options evaluation process relied heavily upon locally developed information. Methods used to develop this information vary from one local agency to the next, making direct comparisons between cost estimates difficult. To make cost information comparable, a common approach for estimating unit cost was developed (Appendix 6C). However, due to lack of detailed information, not all

Options Category Evaluation

Evaluation Criteria	*What is Measured?*	*How is it Measured?*	*Score*
Engineering	Engineering feasibility	Increase score for greater reliance upon current technologies	
	Operational flexibility	Increase score for operational flexibility with existing facilities and/or other options	
	Drought year supply	Increase score for greater drought year yield/ reliability	
	Implementation date	Increase score for earlier implementation date	
	Water quality limitations	Increase score for fewer water quality constraints	
Engineering Score			**0 - 4**
Economics	Project financial feasibility	Increase score for lower overall costs and the ability to finance	
	Project unit cost	Increase score for lower overall unit cost (including mitigation costs)	
Economics Score			**0 - 4**
Environmental	Environmental risk	Increase score for least amount of environmental risk	
	Irreversible commitment of resources	Increase score for least amount of irreversible commitment of resources	
	Collective impacts	Increase score for least amount of collective impacts	
	Proximity to environmentally sensitive resources	Increase score for little or no proximity to sensitive resources	
Environmental Score			**0 - 4**
Institutional/Legal	Permitting requirements	Increase score for least amount of permitting requirements	
	Adverse institutional/legal effects upon water source areas	Increase score for least amount of adverse institutional/legal effects	
	Adverse institutional/legal effects upon water use areas	Increase score for least amount of adverse institutional/legal effects	
	Stakeholder consensus	Increase score for greater amount of stakeholder consensus	
Institutional/Legal Score			**0 - 4**
Social/Third Party	Adverse third party effects upon water source areas	Increase score for least amount of adverse third party effects	
	Adverse third party effects upon water use areas	Increase score for least amount of adverse third party effects	
	Adverse social and community effects	Increase score for least amount of adverse social and community effects	
Social/Third Party Score			**0 - 4**
Other Benefits	Ability to provide benefits in addition to water supply	Increase score for environmental benefits	
		Increase score for flood control benefits	
		Increase score for recreation benefits	
		Increase score for energy benefits	
		Increase score for additional benefits	
		Increase score for improved compliance with health and safety regulations	
Other Benefits Score			**0 - 4**
Total Score			**0 - 24**

option costs could be made comparable. Unit cost estimates took into account capital costs associated with construction and implementation (including any needed conveyance facilities), annual operations costs, and option yield.

Water management options can serve purposes other than water supply; they can also provide flood control, hydroelectric power generation, environmental enhancement, water quality enhancement, and recreation. In recognition of the multipurpose benefits provided by some water management options, the options evaluation scoring process assigned a higher value to multipurpose options, as shown in the sidebar. However, since the focus of the Bulletin 160 series is water supply, cost estimates were based solely on the costs associated with water supply.

Once options were evaluated and scored, they were ranked according to their scores. This ranking was used to prepare a tabulation of likely regional water management options, taking into account options that may be mutually exclusive or could be optimized if implemented in conjunction with other options. Depending on a region's characteristics, its potential options, and its ability to pay for new options, the tabulation of likely options may not meet all of a region's water shortages (especially in drought years).

This appraisal-level evaluation of options at a statewide level of detail is based on presently available information. The ultimate implementability of any water management option is dependent on factors such as the sponsoring entity's ability to complete the appropriate environmental documentation, obtain the necessary permits, and finance the proposed action.

Shortage Management

Water agencies may choose to accept less than 100 percent water supply reliability, especially under drought conditions, depending on the characteristics of their service areas. Shortage contingency measures such as restrictions on residential outdoor watering or deficit irrigation for agricultural crops can be used to meet temporary shortages. Demand hardening is an important consideration in evaluating shortage contingency measures. Implementing water conservation measures such as plumbing retrofits and low water use landscaping reduces the ability of water users to achieve future drought year water savings through shortage contingency measures.

Supply augmentation actions (purchasing water from the DWB) and demand reduction actions (urban rationing and agricultural land fallowing) are available to water agencies for coping with shortages that exceed planned levels of reliability. Table 6-2 summarizes actions taken by some of California's larger urban water suppliers to respond to water shortages in 1991, the driest year of the recent 1987-92 drought. Measures taken by agricultural water agencies and water users included increased pumping of groundwater, land fallowing, and intra- and interdistrict water transfers. The WaterLink system established by Westlands Water District (described in Chapter 8) is an example of an action that could be used by agricultural water suppliers to facilitate intradistrict water transfers as part of managing shortages.

The impacts of allowing planned shortages to occur in water agency service areas are necessarily site-specific and must be evaluated by each agency on an individual basis. In urban areas where conservation measures have already been put into place to reduce landscape water use, imposing rationing or other restrictions on landscape water use can create significant impacts to homeowners, landscaping businesses, and entities that manage large turf areas such as parks and golf courses. Drought year cutbacks in the agricultural sector create economic impacts not only to individual growers and their employees, but also to local businesses that provide goods and services to the growers.

Using Applied Water Budgets to Calculate New Water Needs

As discussed in Chapter 3, some municipal wastewater discharges, agricultural return flows, and required environmental instream flows are reapplied several times before finally being depleted from the State's hydrologic system. An applied water budget explicitly accounts for this unplanned reuse of water. Because reapplication has the potential to account for a substantial portion of a region's water supply, applied water budgets may overstate the supply of water actually needed to meet future water demands. Shortages calculated from an applied water budget must be interpreted with caution to determine new water needs for a region.

The amount of new water required to meet a region's future needs depends on several factors, including the region's applied water shortage, opportunities to reapply water in the region, and the types of water management options that are implemented

TABLE 6-2

1991 Urban Water Shortage Management

		Contingency Measures										
Water Agency[a]	*Reduction Goal*[b]	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*K*
Alameda County WD	18%		✔		✔		✔	✔	✔			✔
Contra Costa WD	26%	✔		✔	✔		✔	✔	✔		✔	✔
East Bay MUD	15%	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	
LA Dept. of Water and Power	15%	✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
MWD of Southern California	31%	✔	✔	✔	✔	✔		✔			✔	✔
MWD of Orange County	20%		✔	✔	✔	✔	✔	✔	✔	✔		✔
Orange County WD	20%			✔		✔		✔	✔			✔
San Diego Co. Water Authority	20%	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
City of San Diego	20%			✔			✔	✔	✔	✔		✔
San Francisco PUC	25%	✔	✔		✔		✔	✔	✔		✔	✔
Santa Clara Valley WD	25%	✔	✔		✔			✔	✔	✔	✔	✔

A = Rationing
B = Mandatory Conservation
C = Extraordinary Voluntary Conservation
D = Increasing Rate or Surcharges
E = Economic Incentives
F = Device Distribution
G = Broadcast Public Information
H = Mailed Public Information
I = Water Patrols and Citations
J = Fines and Penalties
K = Water Transfer

[a] Agencies listed include both wholesale and retail water agencies and, as a result, the shortage contingency measures available to them are different.

[b] The actual performance of an agency's drought management may have exceeded the adopted goal. Several of the retail agencies are located within wholesalers' boundaries. Contingency measures shown can include both retail and wholesale measures.

in the region. If no water reapplication opportunities exist, then the region's new water need is equivalent to its applied water shortage. In this case, the new water need would be independent of the types of water management options that are implemented. However, if opportunities are available to reapply water in a region, then the region's new water need is less than its applied water shortage. In this case, the new water need depends on the types of water management options that are implemented.

Not all water management options are created equal in their ability to meet new water needs. Because supply augmentation options provide new water to a region, the opportunity exists for the options' effectiveness to be multiplied through reapplication. For example, a supply augmentation option may provide 100 taf of new water to a region. But through reapplication within the region, the option effectively meets applied water demands in excess of 100 taf. Demand reduction options, on the other hand, do not provide new water to a region. Hence, the opportunity does not exist to multiply the options' effectiveness through reapplication. To satisfy an applied water shortage of 100 taf, a demand reduction option must conserve 100 taf of water.

Calculation of regional and statewide new water needs is more complex than computing regional and statewide applied water shortages—new water needs also depend on reapplication and implemented water management options. An applied water shortage provides an upper bound on the new water need. A lower bound on the new water need can be estimated for each region by assuming that new water supplies are reapplied in the same proportion that existing supplies are reapplied. Minimum new water needs are computed for each region in Appendix 6D.

The tabulations of likely regional water management options in Chapters 7-9 use minimum new water needs as target values for selecting the appropriate number of regional options. If a region is unable to meet minimum new water needs as a result of regional characteristics, lack of potential options, or inability to pay for potential options, specifying minimum new water needs rather than applied water shortages as regional target values has no impact on options selection. On the other hand, if a region is able to meet its minimum new water needs, this does not necessarily guarantee that all applied water shortages would be met. The remaining applied water shortages would depend on the selected option mix—the more water conservation selected, the greater the remaining applied water shortages would be (as water conservation options do not provide reapplication opportunities.) This approach is consistent with the treatment of shortages in prior water plan updates, which used net water budgets. Because data in net water budgets factor out reapplied water, net water shortages are essentially the same as minimum new water needs. Appendix 6E provides a compilation of Bulletin 160-98 net water budgets, statewide and by region.

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Demand Reduction Options

Demand reduction has taken on a key role in the planning and management of water resources. By making wise use of water through water conservation, the need for new sources of supply can be minimized. Many agencies have implemented programs to achieve a high level of water use efficiency.

For nearly three decades, Californians have recognized the importance of water conservation. Since the 1976-77 drought, attention has focused on plans, programs, and measures to encourage efficient use of water. The water conservation options evaluated in this Bulletin are limited to actions that would have the effect of creating new water supply through reductions in existing consumptive use or water depletions. (The potential for depletion reductions exists where applied water would be lost to evapotranspiration, or to a saline water body, and could not be beneficially reapplied.) The options evaluated in this Bulletin would yield depletion reductions above the 2020-level demand reduction of 2.3 maf assumed to result from statewide implementation of existing BMPs and EWMPs. (Existing BMPs and EWMPs are discussed in Chapter 4.) Quantifying depletion reductions allows the comparison of water conservation options with water supply augmentation options such as water storage or recycling facilities.

The options presented are for planning purposes only and are not mandated targets. They represent an attempt to quantify potential water savings that may be achieved by implementing measures beyond current BMPs and EWMPs. Local water agencies can evaluate these options against other available options to assess appropriate actions for their service areas.

Since the purpose of the Department's Bulletin 160 series is to assess water supply benefits, it is that aspect of water conservation that the Bulletin addresses. Water conservation projects may provide additional benefits, such as reduction in water treatment costs, reduction in fish entrainment at water supply diversion structures, or reduction in nonpoint source runoff. These other benefits are recognized in the Bulletin's options evaluation process, as described earlier. As discussed in Chapter 3, the Bulletin treats demand reduction actions on an equal footing with water supply actions. Each action must create water that is new to the State's hydrologic region.

Data on Urban Landscaping

As plumbing code changes designed to reduce interior urban water use are implemented, a main potential for future urban water conservation lies in reducing exterior urban water use—specifically landscape water use. Estimating water use reductions from landscape irrigation changes is made difficult by the lack of data on irrigated urban landscaping. Only a handful of water districts in California have actual data on the extent of irrigated acreage (residential lots plus large turf areas, such as parks, cemeteries, and golf courses) in their service areas, and data are nonexistent at a statewide level. For planning purposes, California's irrigated urban acreage has historically been estimated at about one million acres at a 1980s/1990s level of development, based on estimated ratios of landscape acreage to total urban acreage from land use surveys. Such ratios vary widely by county (the Department's, for example, vary from percentages in the low teens to almost 40 percent), and are inherently subject to uncertainty. Water agencies are beginning to evaluate ways to quantify existing irrigated urban acreage—aerial photography or satellite imagery, estimated ratios from parcel maps, surveys, or questionnaires. Estimates of future irrigated landscape acreage are generally made by increasing an assumed base acreage by ratios of forecasted population growth—which implicitly assumes no major changes in housing density or single to multifamily housing ratios.

These uncertainties illustrate the present difficulty of quantifying landscape conservation savings, and lack of hard data to support planning estimates. Better estimates of urban landscape acreage would greatly improve future conservation planning.

TABLE 6-3

Urban Depletion Reduction Potential Due to Water Conservation Options Beyond BMPs[a] (taf)

Region	*Opt 1*	*Opt 2*	*Opt 3*	*Opt 4*	*Opt 5*	*Opt 6*	*Opt 7*	*Opt 8*
	New	*New & Existing*	*60 gpcd*	*55 gpcd*	*3%*	*5%*	*7%*	*5%*
	0.8 ET_0 Outdoor Water Use		*Indoor Water Use*		*CII Water Use Reduction*		*Distribution System Losses*	
North Coast	1	6	3	6	1	2	6	9
San Francisco Bay	2	52	38	77	11	18	D	13
Central Coast	4	13	8	17	2	3	3	8
South Coast	67	246	110	220	30	49	D	84
Sacramento River	D	D	D	D	D	D	D	D
San Joaquin River	D	D	D	D	D	D	D	D
Tulare Lake	D	D	D	D	D	D	D	D
North Lahontan	D	1	D	1	D	D	D	D
South Lahontan	20	31	7	15	2	4	4	12
Colorado River	9	18	2	3	1	2	9	13
Total (rounded)	**100**	**370**	**170**	**340**	**50**	**80**	**20**	**140**

[a] In some regions, these levels of conservation are already being achieved. Urban water conservation options beyond BMPs would not result in significant, cost-effective additional reductions in depletion in interior regions and are deferred (D). Only depletion reductions greater than 1 taf are considered in this table.

Although water conservation options will be carried out at the local level, they are discussed in this chapter conceptually as statewide demand reduction options for simplicity of presentation. Analyses of water conservation options for each hydrologic region are discussed in Chapters 7-9.

Urban Water Conservation Options

As discussed in Chapter 4, urban water use forecasts were calculated from estimates of population, urban per capita water use, and conservation savings from urban BMPs. The Bulletin assumes that urban BMPs are put into effect by 2020, resulting in an estimated 1.5 maf of demand reduction statewide.

The urban water conservation options described below assume a more intensive application of current BMPs and potential evolution of additional BMPs. If all of the options described below were implemented, nearly 1 maf/yr of depletion reduction could theoretically be attained. The level of water conserved from these options would vary for each region depending on current urban water use and the region's hydrology. Since little or no depletion reductions would be achieved in the Central Valley, urban water conservation options beyond BMPs are deferred for valley regions. Table 6-3 summarizes statewide urban water conservation options and the potential depletion reductions associated with each option. These options are evaluated for each region in Chapters 7-9.

Outdoor Water Use

Ideally, landscape water use could be derived by the method used for estimating agricultural water use—multiplying water use requirements for different landscape types by their corresponding statewide acre-

Courtesy of Barbara Cross

The greatest potential reductions in urban water use would come from reducing outdoor water use for landscaping. Data for accurately quantifying present acreage of urban landscaping (or for forecasting future acreage) are virtually non-existent today.

age, and summing the results to obtain a total for irrigated landscapes in the State. As discussed in the sidebar, no firm numbers are available for statewide irrigated urban landscape acreage. For this Bulletin, based on water budget data and projected increases in population, landscape water use in California is estimated to increase from about 2.4 maf in 1995 to 3.6 maf in 2020.

The Department estimates that landscape in California will be irrigated on average at 1.0 ET_0 by 2020. Options to reduce outdoor water use assume that statewide landscape irrigation could be reduced on average to 0.8 ET_0 either in new development, or in all development. These reductions would be realized through landscape water audits and incentive programs by retailers. So that the cost of implementing these options can be equitably compared with other supply augmentation options, the economic evaluations in Chapters 7–9 assume that implementation costs are funded by water purveyors and not by homeowners. This assumption implies that water purveyors could choose to carry out landscape water management programs in much the same manner as some urban purveyors have implemented ultra low flush toilet retrofit programs.

Option 1: Outdoor Water Use in New Development to 0.8 ET_0. The Model Landscape Ordinance indicates that a landscape plant factor of 0.8 ET_0 could be attainable through measures such as proper landscape and irrigation system design, more intensive landscape water audit programs, installing automatic rain sensors, better irrigation scheduling, and incentive programs tied to an ET-based billing structure. Statewide, about 100 taf/yr of depletion reductions could be achieved by reducing outdoor water use to 0.8 ET_0 at a cost of about $750/af. The ordinance is directly applicable to new construction; existing landscaping would require retrofitting.

Option 2: Outdoor Water Use in New and Existing Development to 0.8 ET_0. This option extends the provisions of Option 1 to include existing development. Statewide, about 370 taf/yr of depletion reduction could be achieved by reducing outdoor water use in new and existing development to 0.8 ET_0. The cost of this option is difficult to quantify and is greatly affected by site-specific factors. It is expected to be high due to the cost involved in retrofitting existing landscape.

Residential Indoor Water Use

Options to reduce indoor residential water use assume that by 2020, indoor water use in the State would average 65 gallons per capita daily. Options 3 and 4 would reduce this average to 60 gpcd and 55 gpcd, respectively. These reduced levels of indoor water use could be achieved statewide if strong incentive programs, such as financial incentives for retrofits, were provided. More aggressive indoor water audits would be needed. Conversion to horizontal axis washing machines is assumed to occur in 25 percent of all residences under Option 3 and 75 percent under Option 4.

Option 3: Reduce Residential Indoor Water Use to 60 gpcd. This option is based on the potential for a 3 gpcd reduction in leaks, a 1 gpcd reduction in shower usage, and a 1 gpcd reduction in laundry use. These savings result in an 8 percent reduction of applied water beyond current BMPs at the retail level. This option could achieve about 170 taf/yr in depletion reductions at a cost of about $400/af.

Option 4: Reduce Residential Indoor Water Use to 55 gpcd. This option is based on the potential for a 5 gpcd reduction in leaks, a 2 gpcd reduction in shower usage, and a 3 gpcd reduction in laundry use. These savings result in a 15 percent reduction of applied water beyond current BMPs at the retail level. This option could achieve about 340 taf/yr in depletion reductions at a cost of $600/af.

Interior CII Water Use

Urban BMPs account for 12 to 15 percent reduction in commercial, industrial, and institutional water use by 2020. Options 5 and 6 assume that CII water use could be reduced beyond BMPs with aggressive audits and information programs by the retailer. These options could reduce CII water use by an additional 3 percent and 5 percent. The reduction levels are based on measures with varying payback schedules, and also on a national study funded by EPA which identifies potential savings beyond BMPs attainable for various enterprises.

Option 5: Interior CII Water Use by 3 percent. This option is based on measures requiring a five-year start up time with payback in two years. The additional 3 percent CII reduction would require increased water audits and compliance with existing standards and regulations. This option could achieve about 50 taf/yr in depletion reductions, primarily in coastal regions, at a cost of about $500/af.

Option 6: Interior CII Water Use by 5 percent. This option is based on measures requiring an additional five-year start up period with a payback within two to five years. The additional 5 percent reduction would accrue through increased audits and compliance with

CALFED Water Conservation Planning

A technical appendix published with CALFED's March 1998 draft PEIR/PEIS outlined a proposed water conservation approach for urban and agricultural agencies wishing to participate in CALFED program benefits. CALFED's conservation levels differ from those used in Bulletin 160-98. CALFED's assumptions represent its vision of future conservation goals. Bulletin 160-98 uses the approach of forecasting the future based on present conditions. For example, CALFED assumes that new sources of financial assistance and other incentives would be provided to water agencies to encourage high levels of conservation. Bulletin 160-98 assumes that demand reduction options beyond BMPs and EWMPs must be cost-competitive with supply augmentation options, and that no new subsidies or financial assistance programs are provided.

Demand reductions estimated to occur from implementation of CALFED conservation measures were not included in CALFED's quantification of new water supplies potentially generated by the program. Thus, they are also not included in the Bulletin 160-98 quantification of potential new supplies from CALFED.

existing standards, and new efficiency standards. About 80 taf/yr of depletion reduction could be achieved, primarily in the coastal regions, at a cost of $750/af.

Distribution System Losses

The Department estimates that the average unaccounted water in the State's hydrologic regions ranges between 6 and 15 percent. Two percent is attributed to unmetered water use (including water used for construction, fire fighting, and for flushing drains and hydrants) and meter errors; therefore, distribution system losses range between 4 percent and 13 percent. Options to reduce distribution system losses assume that they could be reduced to 7 and 5 percent statewide with more aggressive leak detection and repair programs by the retailer.

Option 7: Distribution System Losses to 7 percent. This option assumes that water system audits would be carried out every three years, leak detection surveys would be conducted from the audits, and repairs would be made. The cost of this option is estimated to be about $200/af. This option would achieve about 20 taf/yr of depletion reductions.

Option 8: Distribution System Losses to 5 percent. This option assumes full metering of all water sources and points of use, annual water audits, leak detection of newly constructed pipelines, and systematic leak detection and repair programs linked to water audits. Implementation of this option would achieve about 140 taf/yr of depletion reduction at a cost of $300/af.

Agricultural Water Conservation Options

Agricultural water use in the Bulletin's 2020 forecast is calculated from estimates of crop acreage, unit applied water, unit ETAW and SAEs. Irrigated crop acreage was 9.5 million acres in 1995 and is expected to decline to 9.2 million acres by 2020 because of urbanization (mostly in the South Coast Region and San Joaquin Valley), westside San Joaquin Valley drainage problems, and changes in CVP water supply in the Central Valley.

Bulletin 160-98 assumes that water purveyors statewide will implement EWMPs by 2020, as described in Chapter 4. The resultant demand reduction is included in the Bulletin's 2020 agricultural water use forecast. Statewide implementation of EWMPs results in about 800 taf/yr of applied water reductions by 2020, largely from canal lining or piping and other measures increasing average on-farm SAE to 73 percent. Recent Department studies have shown that average SAEs might be increased to 80 percent through improved irrigation equipment and irrigation management practices.

The agricultural water conservation options described below were based on attaining SAEs greater than 73 percent, on average, through implementation of conservation measures in excess of present EWMPs. Average efficiencies of 76, 78, and 80 percent were used for the water management options. The Department's mobile laboratory data have shown these efficiencies can be achieved in certain locations and with some crops and irrigation methods.

Stressing orchards to reduce ET (also referred to as regulated deficit irrigation) was not evaluated as an option. The RDI method was used successfully during the drought, but may impact crop yields and needs further testing as a long-term management strategy. RDI and other irrigation techniques are discussed in Chapter 5.

Agricultural demand reduction options are evaluated for each hydrologic region and summarized in Table 6-4. The water conserved from these options varies for each region according to prevailing irrigation practices and the regional soil types and hydrology. As with urban conservation options, the purpose of implementing these agricultural conservation options is to generate new water supply by reducing depletions. Reducing consumptive use results in additional water supply only where water would otherwise be lost to evapotranspiration or to a saline water body such as the Pacific Ocean. In California agriculture, this condition exists primarily in the Colorado River Region (which drains to the Salton Sea), parts of the coastal regions, and the westside of the San Joaquin Valley. In the Sacramento River and the San Joaquin River Regions, almost all excess applied irrigation water is reused, ultimately percolating to usable groundwater or draining back into rivers that flow toward the Delta.

If all of the options discussed below were implemented, about 230 taf of depletion reduction could theoretically be achieved. In areas where no depletion reductions would be achieved by conservation beyond EWMPs (such as the Sacramento and San Joaquin River Regions), this additional conservation was deferred as a water supply option. Most of the potential for achieving depletion reductions through additional agricultural conservation occurs in the Colorado River Region. The environmental impacts of such conservation on the Salton Sea must be carefully evaluated. The Salton Sea provides valuable habitat for migratory waterfowl, and alternatives for stabilizing its increasing salinity are now being studied. Since agricultural drainage provides the bulk of fresh water inflow to the sea, actions reducing the freshwater inflow may not be implementable on a large scale.

Irrigation Management (Options 1, 2, and 3)

By 2020, the Department assumes that on-farm SAEs will average 73 percent statewide. Based on mobile laboratory studies, average SAE could reach 80 percent through programs that include irrigation system evaluations, better system design, and improved irrigation systems and management practices. Options 1, 2, and 3 represent the depletion reductions that would be obtained with improved average SAE at 76, 78, and 80 percent, respectively. Increasing average SAE from 73 to 76 percent would yield a depletion reduction of about 40 taf/yr statewide at about $100/af. Improving SAE from 73 to 78 percent would increase depletion reductions to 60 taf/yr statewide at a cost of $250/af. Improving irrigation management from 73 to 80 percent SAE would result in statewide depletion reductions of about 80 taf/yr at a cost of $450/af.

TABLE 6-4

Agricultural Depletion Reduction Potential Due to Water Conservation Options[a] Beyond EWMPs (taf)

Region	*Opt 1*	*Opt 2*	*Opt 3*	*Option 4*	*Option 5*	*Option 6*
	76%	*78%*	*80%*			
	Seasonal Application Efficiency			*Flexible Water Delivery*	*Canal Lining and Piping[b]*	*Tailwater Recovery*
North Coast	D	D	D	D	D	D
San Francisco Bay	D	D	D	D	D	D
Central Coast	D	D	D	D	D	D
South Coast	4	7	10	D	D	D
Sacramento River	D	D	D	D	D	D
San Joaquin River	D	D	D	2	2	2
Tulare Lake	7	12	17	D	D	D
North Lahontan	D	D	D	D	D	D
South Lahontan	2	3	5	D	D	D
Colorado River[c]	22	36	50	30	45	65
Total (rounded)	**40**	**60**	**80**	**30**	**50**	**70**

[a] Implementing options in certain regions would not result in any depletion reduction. These options are deferred (D). Only depletion reductions greater than 1 taf are presented in this table.
[b] Excludes lining of major conveyance facilities (eg., All American Canal, Coachella Canal), which are treated as individual options in the regional water management chapters.
[c] These options are subject to environmental review to ensure that reduced depletions will not have significant impacts to the Salton Sea.

Land Retirement in Drainage-Impaired Areas

Land retirement has been considered for purposes that include drainage management and creation of wildlife habitat, as well as for potential water supply gains. Currently, two programs have authority to fund land retirement—the CVPIA land retirement program and the San Joaquin Valley Drainage Relief Program created by State legislation in 1992. USBR's CVPIA program has significant funding for land retirement, as described in Chapters 2 and 4. Retiring drainage-impaired land on the westside of the San Joaquin Valley would result in reduction of applied water and depletions associated with the current agricultural land use. The use of this associated water—whether for agricultural, urban, or environmental purposes—would depend on the authority and purpose of the program implementing the retirement.

For illustrative purposes, Bulletin 160-98 quantified demand reductions associated with two land retirement scenarios on the westside of the San Joaquin Valley, where some agricultural lands face serious drainage problems and where the existing land retirement programs are authorized to make acquisitions. This analysis is presented to show the demand reduction amounts and potential associated socioeconomic impacts for these drainage management options. Since the scope of Bulletin 160-98 is limited to water supply/demand planning, the Bulletin does not include land retirement for drainage purposes as a water management option. The results of the land retirement analysis are shown in Appendix 6F.

Water Delivery Flexibility (Option 4)

The manner of water delivery to the farm affects water use and efficiency of use. Flexible water delivery allows a farmer to turn water on and off at will. This is currently impractical for many gravity flow agricultural water delivery systems because of the large volumes of water that must be delivered. However, some agricultural water agencies have been able to allow farmers to give shorter notice to the district before receiving water and to allow farmers to adjust flow rates and the duration of the irrigation. Flexible water delivery beyond that achieved through implementation of existing EWMPs would yield about 30 taf/yr at a cost of about $1,000/af.

Canal Lining and Piping (Option 5)

Increased water use efficiency could be achieved by improving on-farm distribution systems beyond the level of effort provided in existing EWMPs. Distribution system losses can be reduced by lining open canal systems or using pipelines. Pipelines would reduce depletions from evaporation and from seepage of applied water to unusable groundwater. (This option applies only to canal lining and piping of on-farm delivery systems. Lining of major conveyance facilities such as the All American Canal and lining of water agency-owned canals are treated as individual options in Chapters 7-9.)

Lining irrigation canal systems in the San Joaquin River Region could reduce depletions by about 2 taf/yr in areas that drain into unusable shallow groundwater. Less than 1 taf in annual depletion reduction would accrue in the Tulare Lake Region because many irrigation systems on the westside of the valley where there is unusable shallow groundwater are already lined or piped. This option could reduce depletions by 45 taf/yr in the Colorado River Region. It is estimated that this option would cost about $1,200/af.

Tailwater and Spill Recovery Systems (Option 6)

This option would improve irrigation efficiency by the construction of additional tailwater and spill recovery systems. The tailwater recovery option is only applicable to areas with furrow or border irrigation systems. Spill recovery systems would lessen the amount of water reaching unusable groundwater and surface water by reducing losses from operational spills in irrigation district delivery canals. About 70 taf/yr of depletion reductions could be achieved with this option, primarily in the Colorado River Region, at a cost of about $150/af.

Environmental Water Conservation Options

Unlike the urban and agricultural efforts discussed above, little formal planning for environmental water conservation has occurred. Development of a formal program to evaluate efficient water use on wetlands is currently the only active program. DFG, USBR, and USFWS are working with the Grasslands Resource Conservation District to develop an interagency program for water use planning for Central Valley wildlife refuges covered by the CVPIA. The program will include best management practices for efficient water use. Draft work products are expected in 1998. The Bulletin does not quantify options for wetlands water conservation.

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Water Supply Augmentation Options

Presently, most active planning for statewide water supply options is being done either for the CALFED Bay-Delta program or for SWP future supply. In accordance with CVPIA requirements, an appraisal level water supply augmentation report (for replacing the project water dedicated to environmental use) was recently prepared for the CVP. There has not been action to implement potential CVP supply options described in that report, apart from initiation of a conjunctive use study described later in this chapter. Statewide-level supply augmentation options are described in the following text, and a summary table of their potential yield is provided at the end of this section.

Conveyance Facilities

Two programs, the SWP Interim South Delta Program and the CALFED program, are studying conveyance actions in and around the Delta. Past studies have evaluated a potential Mid-Valley Canal, a major conveyance facility to supplement water supplies to the eastern San Joaquin Valley.

SWP Interim South Delta Program

The Department's Interim South Delta Program proposes to improve water levels and circulation in south Delta channels for local agricultural diversions, and to enhance existing delivery capability of the SWP by improving south Delta hydraulic conditions, allowing increased diversions into Clifton Court Forebay. This would allow for more frequent use of full pumping capacity (10,300 cfs) at the Banks Pumping Plant during high flows in the Delta, and more operational flexibility for reducing fishery impacts.

The ISDP partly responds to the proposed settlement of a lawsuit brought by the South Delta Water Agency against the Department and USBR. In the proposed settlement agreement, the three parties committed to develop mutually acceptable long-term solutions to the water supply problems of water users within SDWA. The Department has taken the lead responsibility for planning and constructing the project, with cost-sharing provided by USBR.

The ISDP preferred alternative would cost an estimated $60 million to construct and includes five components:

(1) Construction and operation of a new intake structure at the northeastern corner of Clifton Court Forebay, as part of providing greater operational flexibility in export pumping.
(2) Channel dredging along 4.9 miles of Old River just north of Clifton Court Forebay.
(3) Construction and seasonal operation of a barrier at the head of Old River in spring and fall to improve fishery conditions for salmon migrating in the San Joaquin River. (Construction of an Old River fishery barrier is included in CVPIA's list of mandated federal environmental restoration actions.)
(4) Construction and operation of three flow control structures at Old River, Middle River, and Grant Line Canal to improve existing water level and circulation patterns for agricultural users in the south Delta.
(5) Increased diversions into Clifton Court Forebay up to a maximum of 20,430 af daily on a monthly average basis, resulting in the ability to pump an average of 10,300 cfs at Banks Pumping Plant.

ISDP could augment SWP supplies by 125 taf/yr in average years and 100 taf/yr in drought years at a 2020 level of demand, based on present studies. This figure does not take into account any new operational restrictions that may be imposed on the project as a result of the environmental review and permitting process which it is now undergoing. A draft EIR/EIS for the program was released in July 1996 and ESA consultation is ongoing. A final EIR/EIS is scheduled for completion in 1999.

CALFED Delta Conveyance

The CALFED Bay-Delta program is carrying out a three-phase process for solutions for the Bay-Delta system. In Phase I, the program identified the problems in the Bay-Delta system, developed guiding principles, and devised three basic alternatives to solving the identified problems. The second phase consisted of preparing a programmatic EIR/EIS covering three main alternatives for conveyance of water across the Delta:

- Alternative 1. Water would be conveyed through the Delta using the current system of channels.
- Alternative 2. Water conveyance through the Delta would be substantially improved by making significant changes to the existing system of channels.

Delta levees protect infrastructure such as EBMUD's Mokelumne River Aqueduct, highways, railroads, and power transmission lines.

- Alternative 3. Water conveyance through the Delta would be substantially improved by making significant changes to the existing system of channels and constructing a conveyance facility, isolated from the Delta's natural channels, to transport part or all of the water intended for export.

Each alternative presents options for water storage, as well as a system for conveying water through and/or around the Delta. The water storage element could include expanding existing storage, constructing new surface storage, or conjunctive use and groundwater banking. Additional storage would increase flexibility in operating the Bay-Delta system, allowing operators to respond to changing conditions and needs throughout the year, and would help respond to the effects of drought. Surface storage could be in the Delta, upstream of the Delta, or south of the Delta. Groundwater storage components include conjunctive use and groundwater banking programs in the Sacramento and San Joaquin Valleys and in the Mojave River Basin.

A public review draft of the PEIR/PEIS was released in March 1998. CALFED expects to issue a revised draft PEIR/PEIS by the end of 1998. The revised draft would identify CALFED's draft preferred alternative. The third phase of the CALFED process would involve staged implementation of the preferred alternative, over a time period perhaps as long as 30 years, and would require site-specific compliance with NEPA and CEQA.

In June 1998, it was announced that the second draft of CALFED's PEIR/PEIS would focus on a first stage of program implementation that would be defined as the period prior to final action on any major new surface storage or conveyance projects that might be addressed in CALFED's draft preferred alternative. The first stage was estimated to span seven to ten years. The first stage was to focus on implementation of demonstration projects and actions associated with CALFED common program elements (see accompanying sidebar) and on further planning for water storage and conveyance actions.

The total costs of the CALFED program are difficult to estimate at this time because of its broad scope and programmatic nature, and because decisions have not yet been reached about specifics of implementation. CALFED's PEIR/PEIS estimated total program costs as potentially in the range of

CALFED Bay-Delta Program Common Programs

The following six common program elements provide the foundation for overall improvement in the Bay-Delta system. Each of the individual elements is a major program of its own.

- Long-Term Levee Protection Plan—Improve reliability of the Delta levees to benefit all users of Delta water and land.
- Water Quality Program—Reduce point and non-point source pollution for the benefit of all water uses and the Bay-Delta ecosystem.
- Ecosystem Restoration Program—Improve habitat, restore critical flows, and reduce conflict with other Delta system resources.
- Water Use Efficiency Program—Provide for efficient use of existing water supplies and assure efficient use of any new supplies developed through the program.
- Water Transfer Policy—Provide a framework to facilitate and encourage a water market to move water among users on a voluntary and compensated basis.
- Watershed Management Coordination—Encourage locally-led watershed management activities that benefit Delta system resources.

$10 billion, over a program life of several decades. There is presently no information available on what portion of those costs would be allocated to any new water supply CALFED would develop.

Mid-Valley Canal

The Mid-Valley Canal was a proposed conveyance facility to supplement water supplies to the eastern San Joaquin Valley. With two components—a main branch and a north branch—the canal would convey existing CVP water supply from the Delta to portions of Merced, Madera, Fresno, Kings, and Tulare Counties and, by exchange, Kern County.

The main branch of the Mid-Valley Canal would convey water from the Mendota Pool down the east side of the valley, providing additional water deliveries to the southern San Joaquin Valley and Tulare Lake Basin. The north branch would divert water out of the Mendota Pool to provide additional water deliveries to the eastern San Joaquin Valley. Water deliveries could be provided for conjunctive use and groundwater banking programs, alleviating groundwater overdraft conditions. Improved groundwater conditions through delivery of surplus Delta flows could increase the reliability of drought year supplies. Because of the uncertainty of Delta exports, this option is deferred from further analysis in this Bulletin as a statewide option.

Surface Storage Facilities

Developing additional surface storage is an important option for improving statewide water supply reliability. New facilities could store water for the environment, agriculture, municipalities, industry, or a combination of these uses. More storage would increase flexibility in operating the Bay-Delta system, improving operators' ability to respond to changing conditions and needs throughout the year. At this time, the only statewide-level studies of new surface storage facilities are those relating to the CALFED program.

Area of Origin Protections

As described in Appendix 2A, there are explicit statutory protections for area of origin water development, with regard to actions taken by SWRCB in administering water rights and by the Department in providing SWP supply. These provisions apply to the construction and operation of CVP and SWP facilities and would apply to any CALFED-related facilities constructed by the projects.

At the time when initial planning was being performed for a statewide water resources development system, the State filed applications for the appropriative water rights (including rights to store water) needed for coordinated development of California's water resources. Some of these State filings were subsequently assigned to CVP or SWP facilities, and some to local projects. SWRCB may not, in acting on water right applications for these State filings (e.g., applications for a new surface storage facility), deprive the county of origin of the water needed for its present and future development. Many of these original State filings have now been assigned and the associated facilities have been constructed.

Water Code Sections 11460 et seq. require the Department, with regard to construction and operation of the SWP, to not deprive areas of origin, or "an area immediately adjacent thereto which can conveniently be supplied with water therefrom," of the water reasonably needed for their beneficial uses. Water agencies in the area of origin and adjoining areas could contract with the Department for SWP supply pursuant to this provision. The terms and conditions contained in the contract would depend on the nature of the agencies' needs. If the agency wished to become a SWP contractor on a par with the existing 29 water contractors, the contract would be negotiated in the same manner as the existing SWP contracts. An area of origin agency with different needs might seek a different contractual format. For example, an alternative contractual form might be negotiated for agencies that could carry out local conjunctive use programs to reduce their need for a firm supply from the SWP. Existing SWP contractors pay a share of the costs of developing SWP supply, plus a transportation charge that reflects the cost of water delivery to a contractor's service area. Actual water supply and transportation charges for an area of origin contractor would be determined by the type of water supply needed and the associated transportation facilities. To date, no area of origin agencies have negotiated water supply contracts with the Department.

CALFED Surface Storage

New water supply provided by the CALFED program would come about by implementing some combination of surface storage facilities and conjunctive use programs (discussed later in this chapter). Bulletin 160-98 describes potential CALFED storage facilities and their water supply contributions for illustrative purposes, but does not attempt to identify which facility or facilities CALFED might construct. As presently scheduled, CALFED would not begin construction of a new surface storage facility until after its initial implementation of common program elements. Given the long lead time associated with moving forward on large storage facilities, new water supply from a CALFED facility may not be available by the Bulletin's 2020 planning horizon. The potential new water supply provided by CALFED storage (quantified later in this chapter) is necessarily a placeholder, as no decision has yet been made on a draft preferred alternative. Quantification of CALFED actions for Bulletin 160-98 is based on information provided in CALFED's March 1998 first draft PEIS/PEIR and supporting technical appendices.

For illustrative purposes, the Bulletin's discussion of new CALFED storage facilities treats some of the facilities as if they were part of the SWP, to provide a benchmark for calculating their yields via operations studies. Many of these sites have been studied historically as potential SWP future water supply facilities, and data available for them reflect that intended purpose. The Bulletin's treatment of these facilities as potential components of the SWP is to facilitate their quantification, and is not intended to be a proposal as to the agency that would actually finance, construct, and own them. To date, there has been no determination of how any new supplies developed by CALFED would be allocated.

The following sections present an overview of the locations where new CALFED surface storage facilities could be developed.

Surface Storage Upstream of the Delta. Review of potential statewide surface storage options upstream of the Delta revealed that most of the water development potential of the eastern Delta and San Joaquin River tributaries is likely to be dedicated to local plans. The Sacramento River Basin presents nearly all the potential for additional development to meet statewide needs.

The Sacramento River Basin produces nearly one-third of California's surface runoff. About 16 maf total reservoir storage throughout the basin regulates much of that runoff to support extensive agricultural development within the region, and also provides significant water supply for export to other regions from CVP and SWP facilities. A potential remains for developing additional storage in the basin, as evidenced by frequent winter outflows in excess of in-basin and Delta needs.

Over the past century, hundreds of potential reservoir storage sites have been examined encompassing every significant tributary of the Sacramento River Basin. The most economical and practicable of those were developed, the largest of which are Shasta, Oroville, Berryessa, Almanor, Folsom, and New Bullards Bar. Options for additional storage are primarily past project proposals that were not developed.

The average annual surplus outflow in the Sacramento River Basin is about 9 maf. While this suggests potential for additional storage development, much of the surplus runoff occurs during short periods in years of exceptional flood runoff. For example, a maximum daily flow of about 600,000 cfs flowed past Sacramento during the floods of February 1986 and January 1997. New storage capacity could be developed to capture a small fraction of this surplus. Prospects for the development of additional onstream surface storage reservoirs are discussed in the sidebar.

Besides the onstream reservoir sites proposed over the years, many potential offstream storage sites have been investigated to develop surplus water in the upper Sacramento River Basin. Major planning on such projects began in the 1970s, in the wake of wild and scenic rivers legislation that effectively eliminated additional development of the North Coast rivers. By then, it was also apparent that new storage sites on the Sacramento River were not environmentally feasible, so attention shifted to various onstream tributary reservoirs and to offstream sites. With one exception (Tuscan Buttes Reservoir on Inks Creek, north of Red Bluff), the most promising offstream storage sites investigated during this time lay west of the river from the Stony Creek Basin (Newville and Glenn Reservoirs) south (from Colusa and Sites Reservoirs) to the Putah Creek Basin (enlarged Lake Berryessa). All these projects would require conveyance facilities to divert surplus flow (usually during flood periods) from the Sacramento River, some with potential pump lifts of 300 to 900 feet. (CALFED's studies of storage options are presently examining whether existing facilities such as the Tehama-Colusa Canal could be modified to serve as conveyance facilities for some of the potential offstream storage sites.) Offstream storage projects of this type can be sited to minimize environmental impacts within the inundation area, but diversions from the river involve engineering and environmental challenges.

There has been a revival of interest in other offstream storage possibilities, some new and some that appeared in the Department's Bulletin 3, *The Califor-*

Prospects for Onstream Surface Storage Upstream of the Delta

The seven areas outlined below contribute more than 80 percent of Sacramento River Basin runoff. The remaining runoff originates within the substantial valley floor area and adjacent low- elevation foothills. With few exceptions, streams draining this area are ephemeral, flowing only during and following storms. No consideration has been given to onstream storage on these minor tributaries or nearby valley floor areas, except for discussion of possible winter storage in rice fields.

Upstream from Shasta Dam

About 26 percent of basin runoff originates in this 6,700-square mile tributary area, primarily in the Pit, McCloud, and upper Sacramento Rivers. The availability of water to support additional storage has long been recognized. In the 1930s, Shasta Dam planners considered a larger project, but opted for construction of storage downstream at the Table Mountain or Iron Canyon sites near Red Bluff. When the downstream dam proved environmentally unacceptable, alternatives examined eventually included enlarging Shasta Dam. New storage upstream is possible, but sites are limited by steep topography and extensive existing power development of the Pit and McCloud systems.

Upper Sacramento River Tributaries, Shasta Dam to Red Bluff

This large, but low-elevation, area contributes about one-eighth of Sacramento River Basin runoff. The principal tributaries (in descending order of runoff) are Cottonwood, Cow, Clear, and Battle Creeks. Clear Creek is fully developed by Whiskeytown Lake (a CVP facility). Several reservoir sites have been investigated on the other tributaries, with primary emphasis on Cottonwood Creek. Previously studied reservoir sites are available in this area, but none have proven viable.

Feather River

This is the Sacramento River's largest tributary and contributes 20 percent of basin runoff, an annual average of about 4.5 maf. Lake Oroville at 3.5 maf regulates Feather River flows in most years, but the huge spills in wet years show that the river could support additional storage. Enlargement of Lake Oroville has not been considered practical and the few upstream sites identified in the past have fallen by the wayside for various environmental and economic reasons. No serious planning attention has been devoted to major reservoir storage in the Feather River Basin since construction of Oroville Dam.

Yuba and Bear Rivers

The Yuba River constitutes 11 percent of Sacramento River Basin runoff, but is substantially diminished by power diversions to the adjacent Bear and Feather Rivers. Still, a significant potential for additional storage remains. Proposals for large reservoirs at the Marysville (or nearby Narrows) site have been discussed in the past 40 years. Upstream development potential is restrained by extensive existing power facilities and diversions. The Bear River is small, but its runoff is bolstered by the diversions from the Yuba River.

American River

With 12 percent of Sacramento Basin runoff, the American River could support more than the 1.0 maf of storage provided by Folsom Lake and the nearly 0.5 maf of upper basin storage. For the past decade, recognition of a flooding hazard along the lower American River has added urgency to finding options, including enlarging Folsom Lake and constructing additional storage upstream at Auburn. The controversy over Auburn Dam prompted reappraisal of storage sites farther upstream and on the South Fork, but none appeared to justify follow-up attention.

Westside Tributaries South of Cottonwood Creek

The principal tributaries in this group are (from south to north): Putah, Cache, Stony, Thomes, Elder, and Red Bank Creeks. The existing Lake Berryessa, which has an unusually high storage/inflow ratio, fully develops Putah Creek. Clear Lake and Indian Valley Reservoir provide about 0.6 maf of active storage in the upper Cache Creek Basin, but only modest potential exists for additional storage in the lower basin. East Park, Stony Gorge, and Black Butte Reservoirs partially control Stony Creek, but some surplus water remains. Thomes, Elder, and Red Bank Creeks are presently uncontrolled; Thomes Creek contributes about two-thirds of the runoff from this northern trio. Potential reservoir sites have been considered on the various westside tributaries, principally within the Stony/Thomes Basins.

Other Tributaries, Feather River to Red Bluff

From south to north, the major streams of this group are Butte, Big Chico, Deer, Mill, and Antelope Creeks. These drainages are narrow, steep canyons with good sustained summer flows. Past studies have identified a few small potential storage sites, but none are considered practical because of environmental considerations (primarily anadromous fish and wilderness issues).

nia Water Plan, in 1957. Among the latter is a potential local project, Waldo Reservoir, to store surplus Yuba River water diverted from the existing Englebright Reservoir. Similar proposals have been developed to store surplus American River water from Folsom Reservoir in the nearby Deer Creek or Laguna Creek Basins. Offstream storage projects of this type are attractive because they eliminate the need for onstream reservoirs and divert from existing facilities upstream from current anadromous fishery habitat.

To illustrate how specific surface storage projects upstream of the Delta compare with one another, Bulletin 160-98 planning criteria were used to screen and evaluate the reservoir sites (Appendix 6G). CALFED is performing its own evaluation of possible storage sites. An initial screening may be included in its final PEIS/PEIR. More detailed evaluations of the remaining sites would be carried out after CALFED begins to implement initial elements of the common programs.

Off-Aqueduct Surface Storage South of the Delta. Off-aqueduct surface storage south of the Delta has been investigated for many years. CALFED's storage evaluations include reviewing off-aqueduct storage.

The CVP and SWP operate by releasing water from upstream reservoirs, which flows through the Delta and is diverted, together with unstored flows available for export, by the projects' pumping plants located in the south Delta. Storage south of the Delta is provided by San Luis Reservoir, a joint SWP/CVP facility in the San Joaquin Valley. Water pumped at the Banks and Tracy Pumping Plants is transported to San Luis Reservoir during the winter and early spring and later delivered to agricultural and urban water contractors. Additional storage south of the Delta would increase water availability through greater capture of surplus winter runoff, as well as provide for greater flexibility in operating the projects.

Dependable water supplies from the SWP are estimated at about 3.1 and 2.1 maf for average and drought years, respectively. Operation studies show that under 2020 level of demand, there is a 25 percent chance of delivering full entitlement in any given year with existing facilities. Operation studies show similar CVP delivery capabilities to its Delta export service area. (See Chapter 3 for discussion of SWP and CVP operations.) Additional off-aqueduct storage south of the Delta would increase water supply reliability of both projects.

In addition to increasing water supply reliability for both projects, more off-aqueduct storage south of the Delta would allow flexibility in pumping from the Delta. This flexibility would allow for shifting of Delta pumping toward months when the impacts of Delta diversions on fisheries are at their lowest. Having additional storage south of the Delta would allow the projects to operate efficiently by taking advantage of times when maximum pumping is permissible.

Operation of the SWP and CVP is governed by several limiting factors including available water supplies, demands on these supplies by project contractors, Delta water quality standards, instream flow requirements, and conveyance capability. The availability of water supplies varies with natural conditions and upstream development. Winter floods can produce Delta flow rates of up to several hundred thousand cfs, while summer rates can be as low as a few thousand cfs. Annual Delta inflow varies substantially, ranging from more than 70 maf in wet years to less than 7 maf in drought years.

Since the 1950s, alternative off-aqueduct storage reservoir sites south of the Delta have been investigated by the Department. An agreement between the State and federal governments was signed in 1961 for construction and operation of San Luis Reservoir, a joint-use offstream storage facility completed in 1968. Before completion of San Luis Reservoir, it was recognized that additional storage south of the Delta was needed. As a result, a Delta storage development program was authorized by legislative action in 1963-64, and work started to analyze the remaining potential off-aqueduct storage sites in the San Joaquin Valley. Under this program a cursory examination of potential sites identified the Kettleman Plain, Los Banos, and Sunflower sites for more in-depth study. Kettleman and Sunflower Reservoir sites were dropped after reconnaissance level review because of their physical characteristics. The Los Banos site was deemed satisfactory for further study, and a 1966 report recommended additional geological exploration.

In the 1970s, a Delta alternatives study reviewed all drainages south of the Delta and selected Los Vaqueros, Los Banos Grandes, and Sunflower Reservoirs for further studies. In a 1976 Delta alternatives memorandum report, the Sunflower site was again eliminated when compared with the other sites on the basis of low storage availability and marginal foundation conditions. The Los Vaqueros site in Contra Costa County was included in the Department's proposed Delta program and was part of a comprehensive water management program proposed for authorization via 1977-78 legislation. (LBG was an alternative to Los Vaqueros in that legislation.) After that legislation failed passage, Los Vaqueros was included with the Peripheral Canal in SB 200. LBG was not specifically mentioned in SB 200, but the bill provided for additional off-aqueduct storage south of the Delta. In 1980, SB 200 was signed into law, but was overruled by voters in the 1982 general election.

The Los Banos Grandes damsite area, looking westerly toward the Coast Range.

The Department initiated a more comprehensive investigation of alternative off-aqueduct storage reservoirs south of the Delta in 1983, and after an initial examination of 18 storage sites, completed a reconnaissance report on 13 potential San Joaquin Valley sites. The study recommended that LBG be investigated to determine its most cost-effective size, and its engineering, economic, financial, and environmental feasibility. In 1984, the Legislature unanimously approved Assembly Bill 3792, authorizing LBG as a facility of the SWP. The Department released a draft EIR and a feasibility report on LBG in 1990.

Since the 1990 reports, increased restrictions on Delta pumping and rising costs have prompted reconsideration of the LBG proposal. Given the uncertainty of future Delta exports and the reluctance of some SWP contractors to participate in the project, the Department reevaluated the feasibility and optimal size of additional off-aqueduct storage. A subsequent *Alternative South-of-the-Delta Offstream Reservoir Reconnaissance Study* identified all alternative reservoir sites south of the Delta by cursory examination of all topographic possibilities. An overview of sites studied in the past is provided in Appendix 6G.

In-Delta Storage. CALFED has also considered in-Delta storage. A private developer has proposed a water storage project involving four islands in the Delta. The project would divert and store water on two of the islands (Bacon Island and Webb Tract) as reservoir islands, and seasonally divert water to create and enhance wetlands for wildlife habitat on the other two islands (Bouldin Island and Holland Tract). The developer would improve and strengthen levees on all four islands and install additional siphons and pumps on the perimeters of the reservoir islands.

The developer's project would divert surplus Delta inflows, or would manage transferred or banked water for later sale and/or release for Delta export or to meet Bay-Delta water quality or flow requirements. The reservoir islands would be designed to provide a total estimated initial capacity of 238 taf—118 taf from Bacon Island and 120 taf from Webb Tract—at a maximum pool elevation of 6 feet above mean sea level.

A draft EIR/EIS for the Delta Wetlands Project was completed in September 1995. SWRCB held water rights hearings in 1997. Issues included water quality concerns, levee integrity, seepage impacts on adjacent islands, and fishery impacts. SWRCB is currently reviewing and evaluating the evidence to develop a draft decision.

Multipurpose Storage Facilities

Most reservoirs are constructed to serve multiple purposes. As discussed in Chapter 3, multipurpose reservoirs are often operated to prioritize certain uses or to balance competing uses during different times of the year. Good planning policy dictates that new surface storage facilities be designed to accommodate as many purposes—such as water supply, flood control, hydropower generation, fish and wildlife enhancement, water quality management, and recreation—as are practicable.

Although Bulletin 160 is focused on evaluation of water supply options, this focus is not intended to minimize the need to consider the other benefits potentially available from reservoir sites—especially flood control. The January 1997 flooding, the largest and most extensive flood disaster in the State's history, demonstrated the urgent need to improve flood protection levels throughout the Central Valley. The 1997 *Final Report of the Governor's Flood Emergency Action Team* contained a variety of recommendations for improving emergency response management and flood protection in the Central Valley.

The 1997 floods highlighted a fundamental fact of Central Valley geography—the valley floor is relatively flat, and only an extensive system of levees confines floodwaters to those areas where people would

The January 1997 flooding in the Central Valley emphasized the vulnerability of lands protected by levees.

prefer that they remain. At the beginning of the valley's development in the Gold Rush era, much of the valley floor was an inland sea during the winter months and travel was possible only by boat. This condition was once again experienced on a localized scale in 1997, when numerous levee breaks occurred throughout the valley. Although more emphasis is being given to floodplain management and prevention of future development in flood-prone areas, extensive urban development has already occurred in areas that rely on levees for flood protection. Efforts to improve flood protection for these urban areas necessarily include evaluation of upstream storage alternatives—reoperation or enlargement of existing reservoirs and construction of new reservoirs.

From a flood control standpoint, there are locations within the Sacramento and San Joaquin River systems where additional storage (onstream, or perhaps offstream with appropriate diversion and pumping capability) would be particularly useful. Communities in the Sacramento Valley with greatest need for additional flood protection include the Yuba City/Marysville and Sacramento/West Sacramento areas, as identified in the 1997 *Final Report of the Governor's Flood Emergency Action Team*. An enlarged Shasta Lake could provide additional management of flood flows on the Sacramento mainstem. The need for more flood control storage on the Yuba River has been evaluated for some time, in conjunction with reservoir sites such as the old Marysville site, or the more recent Parks Bar alternative. The proposed Auburn Dam on the American River, selected as the preferred flood protection alternative by the State Reclamation Board, would provide much-needed flood protection for the Sacramento area, which has one of the lowest levels of flood protection of any metropolitan area in the nation.

In the San Joaquin Valley, urbanized areas needing additional protection are those affected by flooding on the mainstem San Joaquin River and on its largest tributary, the Tuolumne River. In the January 1997 flood event, runoff at New Don Pedro Dam on the Tuolumne River and Friant Dam on the San Joaquin River exceeded the flood control capability of both reservoirs. On the Tuolumne River, it appears that new upstream reservoirs are a less likely flood control option, given the basin's existing storage development. Enlarging Friant Dam (or constructing its offstream alternative) would be the most probable new storage development option for the San Joaquin River.

Bulletin 160-98 includes Auburn Dam and Friant Dam enlargement as statewide options likely to be implemented (by CALFED or by others) by 2020. According to CALFED, the capital cost of a 2.3 maf Auburn Dam would be about $2.3 billion in 1995 dollars. According to USBR, the cost of raising Friant Dam by 140 feet with 500 taf additional storage is about $580 million. (This estimate, in 1997 dollars, does not include costs associated with purchasing property, the cost of relocating utilities, and mitigation costs.) Potential yields associated with these projects were estimated through operations studies. A 2.3 maf Auburn Reservoir is estimated to provide 620 taf in average years and 370 taf in drought years. An enlarged Friant Dam is estimated to provide 90 taf in average years. As noted in Appendix 6G, an enlarged Shasta Lake would provide major water supply and other benefits, but additional studies of its costs and environmental impacts would be needed before the

Courtesy of California State Library.

High technology (circa 1900) being used to construct a Sacramento River levee south of the then-downtown area.

project could proceed to implementation. It is recommended that feasibility-level studies of enlarging Shasta be initiated to quantify its costs and benefits. Preliminary studies show that a 9 maf enlargement of Shasta would yield about 760 taf in average years and 940 taf in drought years.

Groundwater and Conjunctive Use

The potential sustainable water supply that could be derived from groundwater storage is constrained by the water available to recharge the storage, the available storage capacity, and the wheeling capability of the conveyance facilities. In most areas the sources of recharge are natural percolation from overlying streams, infiltration of precipitation, deep percolation of applied irrigation water, and seepage from irrigation canals and ditches. In some areas, these sources are augmented by artificial recharge.

Potential for Conjunctive Use in the Central Valley

Plans for local development of additional groundwater and conjunctive use programs are covered in Chapters 7–9. This section reviews the potential for groundwater development and conjunctive use as elements of statewide water management, concentrating on the potential for augmenting supplies of the major State or federal water projects. As noted earlier, conjunctive use programs are also a component of CALFED's storage evaluations.

Sacramento Valley. As noted in the previous discussion of surface storage facilities, the Sacramento River Basin constitutes most of the potential for additional water development to meet statewide demands. Just as surface storage reservoirs are being evaluated to develop a portion of the basin's surplus runoff (about 9 maf), managed conjunctive use programs are being evaluated to the same end.

Although there is a tendency to think of Sacramento Valley groundwater in terms of a homogeneous underground reservoir that fluctuates gradually with wet and dry cycles, the reality is more complex. While much of the Sacramento Valley groundwater basin is interconnected, aquifer structure is far from uniform and horizontal movement of groundwater is slow. Differences in groundwater conditions exist from one area of the valley to another. Even within a small subarea, groundwater resources can range from abundance to scarcity within a few miles.

Potential conjunctive use programs must be evaluated on a site-specific basis, just as surface water storage facilities are evaluated. In concept, Sacramento Valley conjunctive use programs would operate by encouraging existing surface water diverters to make greater use of groundwater resources during drought periods. The undiverted surface water would become available for other users, and groundwater extractions would be replaced during subsequent wetter periods through natural recharge, direct artificial recharge, or in-lieu recharge (supply of additional surface water to permit a reduction of normal groundwater pumping).

The DWB provides an example of conjunctive use in the Sacramento Valley. In 1991, 1992, and 1994, the DWB executed contracts to compensate Sacramento Valley agricultural water districts for reducing their diversions of surface water. Most of the reduced surface water diversions were made up by increased groundwater extractions from existing wells. The 1994 program in this area was the largest, amounting to approximately 100 taf. The DWB program included a groundwater monitoring component to evaluate the effects of increased extractions on neighboring nonparticipating groundwater users. Such monitoring programs would be an important component of future conjunctive use programs.

San Joaquin Valley. Potential conjunctive use projects in the San Joaquin Valley would involve recharging empty groundwater storage space for later withdrawal. Although aquifer storage capacity is available (over 50 maf), a lack of recharge water limits opportunity for conjunctive operation. Even with Delta improvements, prospects for additional groundwater conjunctive use storage south of the Delta are limited. From the standpoint of statewide water supply, the areas of conjunctive use potential are those within reach (either directly or through exchange) of the California Aqueduct or CVP facilities. Examples of projects studied in the past include the Kern Water Bank and the Stanislaus/Calaveras River Basin program. The Kern Water Bank project, described in Chapter 8, was initially developed by the Department and was subsequently turned over to the KWB Authority. The KWB is discussed as a local water management option for the Tulare Lake Region in Chapter 8.

The Department and USBR, in coordination with local agencies, evaluated the possibility of a conjunctive use project in the Stanislaus/Calaveras River Basin. SEWD and CSJWCD proposed a conjunctive use project in 1986 for their CVP interim water supply contracts (155 taf/yr). The districts would divert CVP surface water supply in wet years and would pump

Recharge facilities in the Kern Water Bank area. Levees and conveyance facilities have been constructed to manage spreading of water in the recharge areas.

groundwater and divert South Gulch Reservoir supplies in drought years. Water would be stored in the proposed South Gulch Reservoir, an offstream storage reservoir near the Calaveras River, in wet years. In drought years the districts would allow the water to be released to the Stanislaus River for fishery needs, water quality improvement in the southern Delta channels, and CVP and SWP water supply improvement. Subsequent enactment of CVPIA and issuance of SWRCB's Order WR 95-6 substantially reduced the quantities of surface water available to SEWD and CSJWCD. The Department deferred further participation in this program as a source of SWP supply. Local agencies are continuing to evaluate other conjunctive use programs in this area, as described in Chapter 8.

Recent Groundwater Studies with Statewide Scope

The Department is evaluating conjunctive use opportunities that could provide future water supplies for the SWP. USBR suggested that conjunctive use could be a major option for CVP water users in its 1995 report to Congress, *Least-Cost CVP Yield Increase Plan*. CALFED is examining conjunctive use opportunities as part of its storage evaluations.

SWP Conjunctive Use Studies. The Department's investigation of Sacramento Valley conjunctive use potential for additional SWP supply is following three parallel tracks. The first track is an evaluation of the legal and institutional framework to define potential projects and their limitations. The second track is an inventory of water supply infrastructure, water use, and hydrogeologic characteristics of the valley to identify areas most suitable for conjunctive use projects. The third track is a pre-feasibility investigation of specific potential projects. Where appropriate, these studies recommend more comprehensive feasibility studies, or development of small scale demonstration and testing projects. One such project under evaluation, the American Basin conjunctive use project, is discussed in the sidebar. Under the terms of Monterey Agreement contract amendments now in place for most SWP water contractors, only those contractors interested in receiving supplies from the project would participate in it. Since no other SWP conjunctive use projects are currently in active planning, the yield of the potential American Basin project is used as a surrogate for the yield of SWP conjunctive use programs.

Least-Cost CVP Yield Increase Plan. USBR's 1995 yield increase plan evaluated possible actions to replace the water supply that CVPIA dedicated to environmental purposes. The plan identified conjunctive use as offering the largest potential, estimating that active recharge in the Central Valley would yield over 800 taf/yr. A regional groundwater model characterizing the Central Valley was used to identify potential sites for active recharge programs. Table 6-5 lists potential yield estimates from the study. Yield estimates for active recharge programs were based on the availability of floodflows on adjacent rivers. Local water supply availability has almost always limited the potential of a particular site. Implementation of conjunctive use options would require additional feasibility investigations and identification of potential environmental impacts.

Madera Ranch Project. As described in Chapter 8, USBR is in initial stages of evaluating a conjunctive use project known as the Madera Ranch project, which might yield up to 70 taf/yr. Water supplies for the project would come from excess flows available at the Delta for export. USBR, in cooperation with the San Luis and Delta-Mendota Authority, has completed a preliminary investigation of the project and is now evaluating land acquisition. Since supplies from the potential project would be provided only to one group of CVP contractors and not CVP-wide, the project is discussed as a local project in Chapter 8.

TABLE 6-5

CVP Yield Increase Plan Conjunctive Use Options

General Site Locations	*Potential Source(s) of Water*	*Activity*	*Evaluated Capacity[a] (taf)*	*Annual Yield[b] (taf)*
Region 1				
E of Anderson	Upper Sacramento River	Active recharge	60	15
Region 2				
SW and W of Orland, Tehama-Colusa Canal and vicinity	Upper Sacramento River	Active recharge	360	90
Within Glenn County	Groundwater	Developable yield	N/A	55
Region 3				
S of Chico, near Wheatland, E of Sutter Bypass, and NE of Rio Linda	Feather and Bear Rivers and Dry Creek (north of Sacramento)	Active recharge	280	85
Within Yuba County	Groundwater	Developable yield	N/A	25
Region 4				
NW of Woodland and SW of Davis (near Dixon), Yolo Bypass nearby	Cache Creek, Sacramento River	Active recharge	120	30
Region 5				
NE of Galt, SE of Elk Grove, SE of Lodi, and S of Manteca	American (using Folsom South Canal), Cosumnes, Mokelumne, Calaveras, and Stanislaus Rivers	Active recharge	400	185
Region 6				
NW of Volta and at Oro Loma	Delta-Mendota Canal, California Aqueduct	Active recharge	275	200
Region 7				
N of Modesto	Stanislaus or Tuolumne Rivers	Active recharge	100	20
Region 8				
E of Atwater, NE of Merced, W of La Vina, and NE of Red Top	Merced, Chowchilla, Fresno, and San Joaquin Rivers	Active recharge	350	140
Region 9				
none identified				
Region 10				
N of Raisin City, S of Kingsburg, S of Hanford, W of Visalia, and SW of Tipton	Kings, Kaweah, and Tule Rivers	Active recharge	unknown	125
Region 11				
W of McFarland, and SW of Bakersfield	Kern River, California Aqueduct	Active recharge	500	50

[a] Capacity is taken to be the amount of water that can be recharged and extracted over any area without causing a water level fluctuation of more than 30 feet compared to historical water levels and has been estimated using a large-scale regional model. Values are not maximums and are used for comparison purposes.

[b] Location(s) descriptions are reflective of general areas where active recharge programs were estimated to be feasible. Each reference to a city or town represents a single site (NW of Woodland and SW of Davis refers to two potential site areas). Many regions have multiple sites where active recharge is possible.

CALFED Conjunctive Use Component. CALFED is evaluating conjunctive use potential as part of its storage component. The CALFED conjunctive use program will not identify specific projects, but will attempt to identify potential for groundwater development and provide technical support to voluntary local conjunctive use projects. CALFED is defining operating rules and assumptions in order to evaluate potential water supply benefits. Storage for conjunctive use is currently assumed to be 250 taf in the Sacramento Valley and 500 taf in the San Joaquin Valley. Groundwater withdrawal and recharge capacities of 500 cfs are being assumed. Groundwater withdrawal is being assumed to take place only in drought years. Potential water supply benefits of the CALFED conjunctive use program have not been quantified at this time.

Water Marketing

Water agencies are increasingly including marketing as a component of their future resources mix—not just as a drought management technique, but as a source of supply in normal water years. It is becoming increasingly common to see local agency plans with a menu of marketing alternatives which include one-time spot transfers, short or long-term agreements for drought year marketing, and long-term agreements for average year water marketing.

In this update of the *California Water Plan*, water marketing may include:

- A permanent sale of a water right by the water right holder.
- A lease from the water right holder (who retains the water right), allowing the lessee to use the water under specified conditions over a specified period of time.
- A sale or lease of a contractual right to water supply. Under this arrangement, the ability of the holder to transfer a contractual water right is usually contingent upon receiving approval from the supplier. An example of this type of arrangement is a sale or lease by a water agency that receives its supply from the CVP, SWP, or other water wholesaler.

One common concern with marketing proposals is that only real water is sold, and that marketing of paper water is avoided (see sidebar). The difference is that real water involves a change in the place and type of an existing use without harming another legal user of water, while paper water might involve sale of water that would not otherwise be beneficially used during the period of the proposed marketing arrangement. Another common concern is third-party impacts associated with proposed marketing arrangements. This concern must be addressed as appropriate on a site-specific basis for proposed transfers.

For water marketing options identified as likely to be implemented, Bulletin 160-98 water budgets show increases in supply for the gaining regions and reflect corresponding reductions in demand in regions

Feasibility Study for American Basin Conjunctive Use Project

The Department has completed a feasibility investigation of the American Basin conjunctive use project. Discussions are under way with local project participants and potentially participating SWP contractors. If negotiations are successful, CEQA/NEPA compliance and permit acquisition would follow, and initial project operation might begin in 2001. The project area is in southeastern Sutter County, western Placer County, and northwestern Sacramento County. Local water purveyors participating in the project could include South Sutter Water District, Natomas-Central Mutual Water Company, Pleasant Grove-Verona Mutual Water Company, and Placer County Water Agency. Three of the four potential participants have a surface water supply within the project area from either the Bear or Sacramento River systems, and one relies on groundwater.

As evaluated in the feasibility study, the project could develop about 55 taf of water during drought periods to supplement diminished SWP surface water supplies, depending on the number of agencies participating in the project. In the feasibility study, costs of the drought year supply for the SWP were estimated to be on the order of $150/af.

The 40-30-30 Index (see description in Chapter 3) would be used to determine when project recharge and recovery would occur. When the index is classified as above normal or wet, project recharge would occur. Recharge would be accomplished by in lieu means, which would require delivery of SWP water to those in the project area that use groundwater. Construction of new facilities to deliver SWP water from the Feather River to each project participant's service area would be required. When the index is classified as dry or critical, project recovery would occur by groundwater substitution. Groundwater substitution would involve each district forgoing part of its normal surface water supply, by leaving it in the river for use by others. Reductions in surface water supply would be supplemented by extracting groundwater that was placed in the aquifer system earlier.

Is That Real Water?

The initial rush of enthusiasm for water marketing stimulated much discussion about supposedly unused water. Some water users in the State hold rights (statutory or contractual) to more water than they currently use to meet their needs. Why not sell those rights to others?

Such arrangements looked attractive to both prospective sellers and buyers. The sellers would receive payment for something they were not using, while the buyers would meet urgent water needs. This view, however, overlooks the fact that water to meet the transferred rights has been part of the basin supply all along, and has almost always been put to use by downstream water right holders or is supporting an environmental need. This type of marketing arrangement became known as a "paper water" deal: the money goes to the seller, while the water is sold to the buyer from the supply of an uninvolved third party.

A similar outcome can result from some water conservation measures. Changes in irrigation management can reduce drainage outflow that otherwise contributes to the supply of downstream users or meets an instream need. Proposals to market water saved through such drainage reduction can also represent paper water.

The California Water Code includes a number of provisions to regulate and facilitate marketing arrangements (Water Code Sections 1435, 1706, 1725, 1736, 1810d), as well as a "no-injury" clause that prohibits transfers that would harm another legal user of the water. This clause is the basis for prohibiting sale of paper water.

In analyzing water marketing and water conservation proposals, the Department uses the terms real water and new water to contrast with paper water. Real water is water not derived at the expense of any other lawful user, i.e., water that satisfies the Water Code's no injury criterion. New water is water not previously available, created by reducing irrecoverable losses or outflow to the ocean or inland salt sinks. New water, by definition, must be real, but not all real water is new. For example, water made available through land fallowing is real (because it reduces ETAW), but not new.

from which water is being transferred, if specific participants have been identified and the options are large enough to be visible in the water budgets. Presently, the only marketing arrangements that fit this category are those associated with the draft CRB 4.4 Plan.

One of the larger potential water marketing programs identified in Bulletin 160-98 is CVPIA water acquisition for instream flows and wildlife refuges. Impacts of different levels of supplemental water acquisition were described in USBR's draft CVPIA PEIS, which did not identify a preferred quantity of water acquisition. At this time, no long-term purchase agreements have been executed—CVPIA supplemental water acquired to date has been purchased on a year-to-year basis. It is not possible to identify how and where the supplemental water would be obtained in the future, or what other water demands might be reduced as a result of CVPIA water acquisition.

Sources of Water for Marketing

The increased attention to marketing following the 1987-92 drought brought clear recognition that water marketing alone does not create new supplies—it is a process by which supplies developed by other means are moved to a new place of use. In any water marketing agreement, the reliability of the supply acquired by the transferee depends upon the specific details of the agreement and the relative priority of the water rights involved. Potential sources of water that have been most often considered for marketing are described below:

Land Fallowing. A potential source of water for marketing is to forgo growing crops in a given area and move the water that would have been consumed to a different service area. Although there can be some difficulty in quantifying the amount of water made available and its impact on the economy of local agricultural communities, land fallowing is a proven demand reduction technique. Land fallowing may be undertaken on either a permanent basis (land retirement) or only during drought periods in various forms of shortage contingency programs. Drawbacks of fallowing include potential impacts on non-participating third parties.

Crop Shifts. Some of the third party effects of fallowing could be reduced by substituting crops that consume less water for those that would use more. For example, safflower might be planted in place of tomatoes, or wheat in place of corn. The substituted crop is usually less profitable for the grower, so the potential buyer provides an appropriate incentive payment. Such arrangements can produce real water savings, but they introduce a further layer of complexity and uncertainty. (For example, how can it be demonstrated that the higher water-using crop would really have been planted in the absence of the arrangement? And, what are the related effects on groundwater recharge and drainage contributions to downstream surface supplies?) Crop shift proposals were solicited by the Department for the 1991 DWB, but played a limited role. Because crop acreage is market driven, the ability to do large scale crop shifts is limited. Crop shifts are thus expected to have a small role in water marketing.

Water Conservation and Water Recycling. Where conservation or recycling options result in real water savings, conserved water may be available for marketing to other users. Recent proposals to market conserved water have mostly occurred in the agricultural sector, where considerable confusion has sometimes resulted over the distinction between reducing applied water and producing real water savings. Most of California's irrigated areas overlie usable groundwater basins and are linked by networks of surface streams and drains. Water leaving one area usually contributes to the supply of other areas or, in the Central Valley, to required Delta outflow. Under such conditions, real water savings result by reducing consumptive use or by reducing losses to saline sinks.

From a statewide perspective, opportunities for marketing conserved water occur primarily in areas such as the Imperial Valley, where agricultural drainage water flows to the Salton Sea. (Agricultural runoff entering the sea supplies the relatively fresher water needed to sustain the sea's biological resources. The ability to market conserved water that would otherwise flow to the sea must take into consideration impacts of such transfer on the sea.)

From a local perspective, however, the situation may be different. For example, Sacramento Valley conservation measures that reduce agricultural drainage make more water available for use in the conserving area—but at the expense of downstream users. Local districts in such areas have substantial incentive to practice conservation to improve the utility of their existing supplies, but the potential for creating real water for sale to others is limited.

Water recycling in coastal urban areas can create new water, and there is often a potential market for this water among other urban users for landscape or turf irrigation. These sales typically entail multi-jurisdictional partnerships, since the recycled water is most often provided by a wastewater treatment agency but is distributed or supplied to end users by one or more water agencies.

Groundwater Substitution. Many California growers have rights and access to surface water supplies, even though their land may overlie productive groundwater basins. In such cases, a grower may agree to forgo use of surface water rights for a period, substituting groundwater instead. The unused surface water then becomes available for marketing to other users. This technique was tested during the DWBs of 1991, 1992, and 1994. Under favorable conditions (where wells and pumps are already installed), it can produce considerable water on relatively short notice. One major concern with groundwater substitution is the potential impact on neighboring non-participating pumpers. Substantial monitoring is needed to assure there are no unreasonable third-party impacts. Another consideration with groundwater substitution is that additional pumping may induce recharge that depletes usable streamflow. Only that portion of groundwater replenished from future surplus flows is really a new supply. Further experience will be needed to define the potential of this source, resolve concerns over impacts on nearby pumpers and regional surface supplies, and explore possibilities for constructing recharge facilities.

Surface Storage Withdrawals. Existing reservoirs within California have a combined storage capacity of approximately 40 maf. These facilities are operated by a wide spectrum of entities for a variety of water supply, flood control, power, and recreation objectives. At any given time, water may be stored somewhere in the system that is not planned to be released, but could be made available to meet urgent needs, subject to compliance with existing water rights. Such withdrawals come at a price—usually a reduction of power generation or recreational usage, or increased risk of future water supply shortage. Payments to the reservoir owner implicitly include a component to compensate for reduced benefits, increased risk, and other costs. Surface storage withdrawals are easily quantified and clearly represent real water, provided the storage is refilled from future surplus flows. Storage withdrawals played an important role in recent transfers; the refill constraints were handled through a contract clause whereby reservoir owners agreed to defer refill until a time of future high runoff when there would be no detrimental effect on other water users. In the long run, the prospects for such arrangements will tend to diminish as water demands increase in the reservoirs' primary service areas.

Prospects for Water Marketing

Water marketing will continue to play a role in meeting California's water needs, but there will be a continuing shift in emphasis toward systemwide appraisal of impacts and growing recognition of the need to protect the rights of all lawful water users. Water marketing programs (and land retirement or fallowing programs that may be used to supply water for sale) are often controversial in the area where the trans-

Water Code Section 1810 *et seq.*

1810. Notwithstanding any other provision of law, neither the state, nor any regional or local public agency may deny a bona fide transferor of water the use of a water conveyance facility which has unused capacity, for the period of time for which that capacity is available, if fair compensation is paid for that use, subject to the following:

(a) Any person or public agency that has a long-term water service contract with or the right to receive water from the owner of the conveyance facility shall have the right to use any unused capacity prior to any bona fide transferor.

(b) The commingling of transferred water does not result in a diminution of the beneficial uses or quality of the water in the facility, except that the transferor may, at the transferor's own expense, provide for treatment to prevent the diminution, and the transferred water is of substantially the same quality as the water in the facility.

(c) Any person or public agency that has a water service contract with or the right to receive water from the owner of the conveyance facility who has an emergency need may utilize the unused capacity that was made available pursuant to this section for the duration of the emergency.

(d) This use of a water conveyance facility is to be made without injuring any legal user of water and without unreasonably affecting fish, wildlife, or other instream beneficial uses and without unreasonably affecting the overall economy or the environment of the county from which the water is being transferred.

1811. As used in this article, the following terms shall have the following meanings:

(a) "Bona fide transferor" means a person or public agency as defined in Section 20009 of the Government Code with a contract for sale of water which may be conditioned upon the acquisition of conveyance facility capacity to convey the water that is the subject of the contract.

(b) "Emergency" means a sudden occurrence such as a storm, flood, fire, or an unexpected equipment outage impairing the ability of a person or public agency to make water deliveries.

(c) "Fair compensation" means the reasonable charges incurred by the owner of the conveyance system, including capital, operation, maintenance, and replacement costs, increased costs from any necessitated purchase of supplemental power, and including reasonable credit for any offsetting benefits for the use of the conveyance system.

(d) "Replacement costs" means the reasonable portion of costs associated with material acquisition for the correction of unrepairable wear or other deterioration of conveyance facility parts which have an anticipated life which is less than the conveyance facility repayment period and which costs are attributable to the proposed use.

(e) "Unused capacity" means space that is available within the operational limits of the conveyance system and which the owner is not using during the period for which the transfer is proposed and which space is sufficient to convey the quantity of water proposed to be transferred.

1812. The state, regional, or local public agency owning the water conveyance facility shall in a timely manner determine the following:

(a) The amount and availability of unused capacity.

(b) The terms and conditions, including operation and maintenance requirements and scheduling, quality requirements, term or use, priorities, and fair compensation.

1813. In making the determinations required by this article, the respective public agency shall act in a reasonable manner consistent with the requirements of law to facilitate the voluntary sale, lease, or exchange of water and shall support its determinations by written findings. In any judicial action challenging any determination made under this article the court shall consider all relevant evidence, and the court shall give due consideration to the purposes and policies of this article. In any such case the court shall sustain the determination of the public agency if it finds that the determination is supported by substantial evidence.

1814. This article shall apply to only 70 percent of the unused capacity.

ferred water would originate because of potential third-party impacts. Mechanisms for evaluation and approval of water marketing arrangements have been developed, and will likely continue to evolve. For example, USBR developed guidelines for implementing sale of CVP water under CVPIA; the California Water Code directs the Department to facilitate voluntary exchanges and transfers of water; and 1992 changes to State law authorized water suppliers (local public agencies and private water companies) to contract with water users to reduce or eliminate water use for a specified period of time, and to sell the water to other water suppliers and users.

The ability to carry out marketing is dependent on conveyance provided by California's existing rivers, canals, and pipelines. Agencies planning to use long-term marketing arrangements as part of their core water supplies must have access to reliable conveyance for these supplies. The California Water Code requires that public agencies make available unused conveyance capacity if fair compensation is paid and other conditions are met (see sidebar). The CVP and SWP wheel water for marketing; only the SWP can convey water from the Central Valley to the highly urbanized South Coast Region. A long-term Delta fix is necessary for providing reliable conveyance of acquired supplies across the Delta. Actions that constrain agencies' abilities to con-

TABLE 6-6
Sample of Potential Water Purchases (taf)

	Average	*Drought*
Drought Water Bank	—	250
CVPIA Interim Water Acquisition Program	365	365
Zone 7 Water Agency	50	50
Alameda County Water District	15	25
Contra Costa Water District	50	40
Santa Clara Valley Water District	100	100
Westlands Water District	200	200
Metropolitan Water District of Southern California	—	300
San Diego County Water Authority	200	200
Total	**980**	**1,530**

vey water across the Delta limit their ability to enter into marketing arrangements.

As more agencies rely on water marketing to balance future demand and supply, and as several large-scale environmental restoration programs begin acquiring water for fishery and habitat purposes, competition for available water will increase. The availability of water for sale in marketing programs is inherently limited by the willingness of the existing water rights holders to participate in such programs. Table 6-6 shows a few larger marketing arrangements proposed in water agency planning documents to illustrate the magnitude of purchases being considered.

Water marketing depends on the availability of conveyance for the transferred water. For example, the East Branch of the California Aqueduct is the only inter-regional conveyance facility serving rapidly urbanizing areas in the southwestern corner of the Mojave Desert. Availability of aqueduct capacity would dictate the conditions under which transfers to this area could occur.

The following sections describe some specific water marketing proposals. Many local agencies may intend to buy water on the spot market as needed to respond to service area demands, but do not have agreements or defined programs in place at this time.

Drought Year Marketing

Marketing Involving SWP Facilities. The DWB program is a water purchasing and allocation program that allows the Department to purchase water from willing sellers and market the water to buyers under specific critical needs allocation guidelines. The DWB's EIR established the bank as a 5 to 10 year program. Chapter 3 describes past DWB activities. The quantities and prices of water made available in previous years through surplus reservoir releases, groundwater substitution, and land fallowing programs are summarized in Table 6-7. Past experience suggests that about 250 taf/yr could be allocated in the future through similar programs; this quantity is used for the future supplies associated with the DWB.

The Department had proposed a supplemental water purchase program to increase water supply reliability for SWP contractors. A draft programmatic EIR for the six-year program originally proposed transfer of up to 400 taf of water in drought years. The water would be purchased from willing sellers and provided to participating SWP contractors. After a number of public workshops, the Department reevaluated the program and eliminated its groundwater component. Without the groundwater component, the maximum supply available for transfer would have been 200 taf/yr. Additional public comments received on the draft PEIR raised issues that would need to be addressed

TABLE 6-7

Drought Water Bank Summary

Year	*Purchase Price ($/af)*	*Source of Drought Water Bank Water (taf)*				*Amount Allocated[a] (taf)*
		Surplus Reservoir Storage	*Groundwater Substitution*	*Fallowing*	*Total Sources*	
1991	125	147	259	415	821	390
1992	50	32	161	0	193	159
1994	50	33	189	0	222	174

[a] Amount allocated for urban, agricultural, and environmental uses. This represents the actual supply developed by the bank after conveyance and fish and wildlife requirements were met.

in site-specific environmental documents. The Department withdrew the draft PEIR due to the difficulty of addressing site-specific concerns in a programmatic environmental analysis and after reevaluating the potential benefits of the program. The supplemental water purchase program is not considered as a future water management option in the Bulletin.

Semitropic Water Storage District has developed a groundwater storage program with a maximum storage capacity of 1 maf and maximum annual extraction of 223 taf. Under this program, a banking partner may contract with SWSD to deliver its SWP water or other water supplies to SWSD for in-lieu groundwater recharge. At the contractor's request, groundwater would be extracted and delivered to the California Aqueduct or would be pumped by SWSD farmers in exchange for SWP entitlement deliveries. Currently, MWDSC and SCVWD have long-term agreements with SWSD for 350 taf of storage for each district. ACWD has a similar agreement for 50 taf of storage, as does Z7WA for 43 taf. There is about 200 taf of capacity available for other banking partners and for increased commitments by existing partners. Participants are not restricted to SWP contractors, although access to the SWP's conveyance system is necessary. This program, discussed in more detail in Chapter 8, is considered a marketing arrangement in this Bulletin because of the possible exchange of SWSD's SWP entitlement for banked SWP water. The cost of recharging and extracting this water is about $175/af.

A similar marketing agreement has been reached by Arvin-Edison WSD and MWDSC for up to 350 taf of storage in Arvin-Edison's groundwater basin. About 60 taf would be withdrawn and delivered to MWDSC through the California Aqueduct in drought years at a cost of about $200/af, exclusive of delivery costs to member agencies.

Marketing Involving CVP Facilities. Historically, users of CVP water have made intra-district, and sometimes inter-district transfers of project supply. The 1992 enactment of CVPIA provided the authority to market project water outside of project boundaries to nonproject water users.

The San Luis & Delta-Mendota Water Authority, which represents 32 urban and agricultural water districts on the west side of the San Joaquin Valley and in San Benito and Santa Clara Counties, has developed an agreement that will help its members cope with water supply uncertainties. Under a three-way agreement between the authority, SCVWD, and USBR, participating member districts (shortage year providers) can receive some of SCVWD's federal water allocation in normal and above-normal water years in exchange for committing to make available a share of the shortage year provider's federal allocation during drought years. The agreement, which does not require any additional exports from the Delta, will be an internal reallocation of existing federal supplies to allow greater flexibility in meeting urban and agricultural water demands.

Specifically, SCVWD will provide 100 taf of water within a 10-year period for reallocation by USBR to shortage year providers. In exchange, shortage year providers will provide SCVWD with shortage year protection. The agreement directs USBR to reallocate drought year supplies (not to exceed an annual total of 14.3 taf) so that at least 97.5 taf is delivered to SCVWD in years when the CVP's urban water deliveries are 75 percent or less of contract entitlement. As part of the agreement, SCVWD will optimize its use of non-CVP water supplies, which will benefit all CVP irrigation water service contractors in the Delta export service area. Westlands Water District and San Luis Water District have already agreed to become shortage year providers; other authority members may also enter into the agreement over time.

CVPIA authorized marketing of project water outside the CVP service area, subject to numerous specified conditions, including a right of first refusal by existing CVP water users within the service area. As of this writing, no marketing arrangements have either been approved or implemented under this provision. One proposed transfer that had been discussed was between Arvin-Edison WSD and MWDSC.

Marketing Involving Colorado River Aqueduct. In its 1996 session, the Arizona Legislature enacted legislation establishing the Arizona Water Banking Authority. The Authority is authorized to purchase unused Colorado River water and to store it in groundwater basins to meet future needs. Conveyance to storage areas is provided by the Central Arizona Project. The legislation further provided that the Authority may enter into agreements with California and Nevada agencies to bank water in Arizona basins, with specific limitations. Under this legislation, future interstate banking in Arizona would have a maximum drought year yield of 100 taf. As described in Chapter 9, federal regulations to implement interstate banking are being promulgated.

As discussed and quantified in Chapters 7 and 9, a variety of arrangements are being examined as part of the development of CRB's draft 4.4 Plan. Land fallowing programs could be implemented to provide water for marketing to urban areas during drought periods, as demonstrated by one test program conducted in the Colorado River Region. In 1992, MWDSC began a two-year land fallowing test program with Palo Verde Irrigation District. Farmers in PVID fallowed about 20,000 acres of land. The saved water, about 93 taf/yr, was stored in Lake Mead for future use by MWDSC. (The water was subsequently released when flood control releases were made from Lake Mead). MWDSC paid each farmer $1,240 per fallowed acre, making the costs of the water to MWDSC about $135/af. It is expected that similar programs could be implemented in the future by agencies in the South Coast Region and Colorado River Region to provide about 100 taf during drought years.

Every Year Marketing

Permanent Sales. The Monterey Agreement provides that 130 taf of SWP agricultural entitlement be sold to urban contractors on a willing buyer-willing seller basis. Several sales of entitlement have already been implemented. KCWA permanently sold 25 taf/yr of entitlement to MWA and is in the process of finalizing the permanent sale of 7 taf/yr to Z7WA. KCWA is arranging sale of additional entitlement to Castaic Lake Water Agency. As with the SWP, marketing of contractual entitlements among CVP contractors is occurring. The CVP drought year reallocation agreement described above represents a new approach to marketing among project water users.

CVPIA Interim Water Acquisition Program. Sales of developed supplies for environmental purposes (where the transfer occurs as part of a willing buyer-willing seller arrangement, and not as the result of a regulatory action) are a relatively recent occurrence. Under the CVPIA supplemental water provisions, USBR established an interim water acquisition program that was in effect from October 1995 through February 1998. Water was acquired to meet near-term fishery and refuge water supply needs while long-term planning for supplemental water acquisition continued.

As provided in the program's environmental documentation, USBR could acquire up to 100 taf annually on each of the Stanislaus, Tuolumne, and Merced Rivers. Acquired water would be used for instream flows on the three rivers, and for flow and water quality improvements on the San Joaquin River. The specific quantities of water to be acquired each year and associated release patterns would depend upon projected flow conditions in the individual rivers, and projected flow and water quality conditions in the San Joaquin River at Vernalis. USBR would also acquire up to 13 taf of water annually from the Sacramento and Feather River Basins for Sacramento Valley wildlife refuges. Likewise, up to 52 taf would be purchased annually from willing sellers in the San Joaquin Valley for refuges there.

CVPIA AFRP Water Acquisition Program. USBR's 1997 draft PEIS analyzed four alternatives for long-term acquisition of fishery and refuge waters.

- Alternative 1. No water would be acquired to meet fish and wildlife targets.
- Alternative 2. AFRP water would be acquired annually from willing sellers on the Stanislaus (60 taf/yr), Tuolumne (60 taf/yr), and Merced Rivers (50 taf/yr) and on Upper Sacramento River tributary creeks that support spring-run salmon populations. Acquisition amounts on the tributary creeks were not quantified in the PEIS. Acquired water would be managed to meet target instream flows and would also be used to improve flows in the Delta. The acquired AFRP water could not be exported by the CVP or SWP.

Refuge water supply would be acquired to provide the incremental difference between Level 2 and Level 4 refuge supply requirements. Annual water acquisition in the Sacramento River, San Joaquin River, and Tulare Lake Regions would be about 30 taf, 80 taf, and 20 taf, respectively.

- Alternative 3. AFRP water would be acquired annually from willing sellers on the Yuba (100 taf/yr), Mokelumne (70 taf/yr), Calaveras (40 taf/yr), Stanislaus (200 taf/yr), Tuolumne (200 taf/yr), and Merced Rivers (200 taf/yr) and on Upper Sacramento River tributary creeks for in-stream flows. As in Alternative 2, acquisition amounts on the tributary creeks were not quantified in the PEIS. The acquired AFRP water would not be managed for increased flows through the Delta. Therefore, it could be exported if Order WR 95-6 conditions were met. Refuge water would be acquired to meet Level 4 requirements in the same quantities as described in Alternative 2.
- Alternative 4. AFRP water would be acquired annually for instream flow as under Alternative 3. Acquired water would be managed to meet target instream flows and to improve flows in the Delta. Therefore, the acquired water could not be exported by the CVP or SWP. Refuge water would be acquired for Level 4 water supplies in the same manner as described in Alternative 2.

To help put the magnitude of these amounts into perspective, the draft PEIS estimates a reduction of 142,000 acres of irrigated agricultural land would be needed to provide CVPIA water acquisitions under Alternative 4, entailing water acquisition costs of up to $120 million per year. Approximately 21,000 acres would be fallowed in the Sacramento River Region, 118,000 acres would be fallowed in the San Joaquin River Region, and 3,000 acres would be fallowed in the Tulare Lake Region. Since USBR has not yet identified a preferred alternative or specific proposals for transfers, Bulletin 160-98 does not include these CVPIA transfers in the water budgets. To the extent that the acquired water reduces demands by other water users, the water acquisition would have minimal net impact on the water budgets.

Colorado River Marketing Arrangements. Water agencies in the South Coast Region will continue to pursue programs to offset the reduction in existing supplies resulting from California reducing its use of Colorado River water. This subject is covered in detail in Chapter 9. MWDSC and IID have already implemented an agreement to transfer conserved water to urban users in the South Coast Region; a similar agreement was recently executed by SDCWA and IID. Both of these arrangements represent long-term transfers of core supplies. The next step in implementing the IID/SDCWA arrangement is preparation of environmental documentation. Once implemented, transferred amounts would increase over time (up to a 75-year term) to a maximum of 200 taf annually. In order to convey the acquired water, SDCWA negotiated a wheeling agreement with MWDSC for use of capacity in MWDSC's Colorado River Aqueduct.

Water Recycling and Desalting

Water Recycling

The Department, in cooperation with the WateReuse Association of California conducted a water recycling survey as described in Chapter 3. Table 6-8 shows 2020 base level of water recycling and potential future options. These options represent potential maximum levels of recycling. Not all options are expected to be implemented, due to economic and other considerations.

New water supply would be generated by water recycling where the outflow of water treatment plants would otherwise enter a salt sink or the Pacific Ocean. In the Central Valley and other inland communities, outflow from wastewater treatment plants is discharged

TABLE 6-8

2020 Level Water Recycling Options and Resulting New Water Supply (taf)

Projects	*Total Water Recycling*	*New Water Supply*
Base	577	407
Potential options	835	655
Total	**1,412**	**1,062**

TABLE 6-9

Potential 2020 Water Recycling Options by Hydrologic Region (taf)

	Total Water Recycling	*New Water Supply*
North Coast	15	0
San Francisco Bay	101	91
Central Coast	39	37
South Coast	639	527
Sacramento River	6	0
San Joaquin River	7	0
Tulare Lake	25	0
North Lahontan	0	0
South Lahontan	3	0
Colorado River	0	0
Total	**835**	**655**

into streams and groundwater basins and is generally reapplied. Recycling of such outflow would not generate new water supplies. All new recycled water is expected to be produced in coastal regions—the San Francisco Bay, Central Coast, and South Coast regions.

Water agencies in the South Coast Region are concerned that the lack of future high-quality water for blending supplies, or the cost of desalting recycled water, could affect implementation of future water recycling facilities. Due to extensive use of Colorado River water and groundwater supplies that are relatively high in TDS, salt management is an important consideration in marketing recycled water in the region. Salt management options include blending Colorado River water and groundwater supplies with other sources such as SWP water, or treating (i.e., desalting) the recycled water to reduce its salt content. MWDSC and its member agencies and USBR are cooperating in a salinity management study. The study's initial phase focuses on identifying problems and salinity management needs of MWDSC's service area. This study is discussed in Chapter 7.

Table 6-9 shows potential water recycling options by hydrologic region. Two major water recycling programs being planned are the Bay Area regional water recycling program and the Southern California comprehensive water reclamation and reuse study, discussed in detail in Chapter 7.

Desalting

Today, California has more than 150 desalting plants providing fresh water for municipal, industrial, power, and other uses. The freshwater capacity of these plants totals about 66 taf annually, a 100 percent increase since 1990. Common feedwater sources for desalting plants include brackish groundwater, municipal and industrial wastewater, and seawater. Groundwater recovery currently makes up the majority of desalting plant capacity, 45 taf/yr. Wastewater desalting accounts for 13 taf/yr and seawater desalting accounts for 8 taf/yr of total capacity.

Groundwater recovery and wastewater recycling will be the primary uses of desalting in California in the foreseeable future. (The use of desalting in wastewater treatment plants is part of water recycling and is included in the water recycling section.) Improvements in membrane technology will spur considerable growth in these areas, as discussed in Chapter 5. Seawater desalting is expected to grow very slowly.

Groundwater Recovery. High TDS and nitrate levels are common groundwater quality problems. Groundwater recovery programs can be designed to treat mineralized groundwater or groundwater with nitrate contamination, as shown in the examples given in Chapter 5. Currently, most groundwater recovery programs under consideration are located in the South Coast Region (excluding groundwater recovery solely to remediate contamination at hazardous waste sites). Some of the polluted water must be treated and some can be blended with better quality water to meet water quality standards. The potential annual contribution of groundwater recovery by year 2020 is about 110 taf, with 95 taf in the South Coast Region. Options are discussed in the regional chapters.

Seawater Desalting as a Future Water Management Option

Seawater desalting was often viewed with optimism as a future water management option for California in the 1950s and 1960s, because of the proximity of the State's major urban areas to the Pacific Ocean. Most planning efforts then were focused on studies and small-scale or pilot plant demonstration projects. Seawater desalting is expected to have only limited application during the Bulletin 160-98 planning horizon, largely due to its costs. The excerpt below, taken from a 1965 USGS report entitled *Natural Resources of California*, describes an early demonstration project. (A 1 mgd plant, operated continuously, would provide 1.1 taf per year.)

California is cooperating with the Federal Government in a saline water conversion program. The Department of the Interior and the State jointly financed the building of a saline water conversion plant in San Diego on a site donated by the city. Capable of producing 1 million gallons of water a day, it was operated for 2 years before being dismantled in March of 1964 and shipped to Cuba to serve Guantanamo Naval Base there. It is being replaced by a joint effort of the Department [of Interior] and the California Water Resources Board. The State and the Federal Government are also cooperating in the development of a multi-million-gallon saline water conversion plant.

Seawater Desalting. The major limitation to seawater desalting has been its high cost, much of which is directly related to high energy requirements. Seawater desalting costs typically range from $1,000 to $2,000/af depending in part on the extent to which existing infrastructure, such as brine disposal facilities, is present. With few exceptions, its costs are greater than costs of obtaining water from other sources. However, seawater desalting can be a feasible option for coastal communities that are not connected to statewide water distribution infrastructure and have limited water supplies. Because of such circumstances, seawater desalting plants have been constructed in the Cities of Avalon, Santa Barbara, and Morro Bay. Seawater desalting plants can be designed to operate only during drought to improve water supply reliability, as is the case for Santa Barbara's desalter.

During the 1987-92 drought, plans to install and operate several seawater desalting plants were under consideration in the Central Coast and South Coast Regions, including plans for several large distillation plants using waste heat from existing thermal power plants in the South Coast Region. The total potential of the proposed plants was about 123 taf /yr. With the return to average water supply years, most of these plans have been put on hold. Currently, seawater desalting is most favorable as a drought year option. If desalting costs are substantially reduced in the future, plant capacity which is surplus to the plant owners in wetter water years could be used to produce water for conjunctive use or marketing programs.

MWDSC's research distillation plant is the only large non-reverse osmosis facility now under study. MWDSC, in cooperation with the federal government and the Israel Science and Technology Foundation, is completing final design of a 12.6 mgd demonstration desalting plant to evaluate a future full scale 60 to 80 mgd seawater desalting plant. The technology is based on a multiple-effect distillation process which uses heat energy from an adjacent powerplant. The

Mission Basin Brackish Groundwater Desalting Research and Development Project

The Mission Basin groundwater desalting project is an example of the type of desalting projects likely to occur within the Bulletin's planning horizon.

The City of Oceanside owns and operates the Mission Basin Groundwater Desalting Facility. Under current operations, about 2.1 taf/yr of demineralized groundwater supply is produced from treating brackish groundwater through a reverse osmosis process. Because of the plant's successful operation over the past three years, the city plans to expand its production capacity to 7.1 taf/yr, 22 percent of the city's average annual demand. The cost of the expansion is estimated to be $9.0 million. The additional water supply is expected to be available in year 2000.

The Mission Basin aquifer holds about 92 taf of water. The city anticipates that at least half of its future water supply can ultimately be derived from this source. Expansion of the Mission Basin Desalting Facility has several important benefits. It would provide the city with a local source in the event of a natural disaster, such as an earthquake. In addition to reducing the city's reliance on imported water, the quality of water produced at the desalting facility is better than that of the city's imported source (TDS concentration of 400-500 mg/L versus 600-700 mg/L for imported water).

goal is to demonstrate that the multiple-effect distillation process can produce desalted seawater at a cost of less than $1,000/af. If successful, a full scale plant could produce about 85 taf/yr.

Weather Modification

Weather modification (cloud seeding) has been practiced in California for years. Most projects have been located on the western slopes of the Sierra Nevada and in parts of the Coast Range. Before the 1987-92 drought, there were about 10 to 12 weather modification projects operating, with activity increasing during dry years. During the drought the number of projects operating in California had increased to 20. Some projects were subsequently dropped and others suspended operations after the drought ended.

Operators engaged in cloud seeding have found it beneficial to seed rain bands along the coast and orographic clouds over the mountains. The projects are operated to increase water supply or hydroelectric power generation. Although the amounts of water produced are difficult and expensive to determine, estimates range from a 2 to 15 percent increase in annual precipitation, depending on the number and type of storms seeded.

The Department, on behalf of the SWP, planned a five-year demonstration program of cloud seeding in the upper Middle Fork Feather River Basin, beginning in the 1991-92 season. The program was to test the use of liquid propane injected into clouds from generators on a mountain top. The test program was terminated after three years due to institutional difficulties.

A 1993 USBR feasibility study for a cloud seeding program in the watersheds above Shasta and Trinity Dams indicated potential for the Trinity River Basin, but cast doubt on the effectiveness of a project for Shasta Lake. USBR had proposed a cloud seeding demonstration program in the upper Colorado River Basin, but the demonstration program was opposed by the State of Colorado. Presently, USBR is phasing out its participation in weather modification projects.

Cloud seeding is more successful in near-normal water years, when moisture in the form of storm clouds is present to be treated. It is also more effective when combined with carryover storage to take full advantage of additional precipitation and runoff. Institutional issues associated with cloud seeding programs include claims from third-parties who allege damage from flooding or high water caused by the cloud seeding program. Because of the many legal and institutional difficulties surrounding third-party impacts, new cloud seeding projects are deferred from further consideration in this Bulletin.

Monterey County Water Resources Agency's Cloud Seeding Program

MCWRA initiated a cloud seeding program in 1990 to alleviate impacts of the drought and has continued the program as a cost-effective way to augment water supplies. MCWRA's program costs were less than $10/af. In addition to airborne seeding, an experimental ground based propane dispenser was installed for rainfall enhancement in 1991. The program was designed to increase rainfall and runoff in the watersheds of Arroyo Seco (a small undammed tributary of the Salinas River) and San Antonio and Nacimiento Reservoirs.

Monterey County relies solely on groundwater and local surface supplies, and faces chronic groundwater overdraft and seawater intrusion. The area's semiarid, Mediterranean-style climate provides only marginally sufficient rainfall during average years to sustain reservoir releases for aquifer recharge during the summer months. Furthermore, the occurrence interval and typical productivity of weather systems passing over the central coast are such that soil mass only reaches saturation near the end of the rain event, and the weather system moves on prior to the occurrence of substantial runoff. Cloud seeding, in most cases, provides additional rainfall that converts directly into runoff.

The typical interval for cloud seeding in Monterey County is from early November through the end of March. The primary target area is the 650 square miles of combined watershed above Nacimiento and San Antonio Reservoirs. To the north, the Arroyo Seco watershed is a secondary target area. Seeding flights in the early part of the water year cover the entire area, affecting the reservoir drainage areas and Arroyo Seco. This early seeding provides additional runoff to the reservoir system as well as added groundwater recharge in the Arroyo Seco drainage area. Later in the water year when Arroyo Seco flows have reached the confluence with the Salinas River, flights are rerouted to concentrate the seeding effect on the reservoirs.

The five-year program has experienced varying degrees of success in terms of providing additional water supply. Usually the wetter the storms, the greater the moisture available for conversion to precipitation and the more productive the seeding. Overall, evaluations show that rainfall increased about twenty percent above normal for the five-year study period. According to MCWRA, no known adverse environmental effects have occurred as a result of the project.

Other Supply Augmentation Options

This section discusses several other methods to augment water supplies. These options are conceptual, or have not yet been widely practiced. Hence, they are deferred from further evaluation in this Bulletin.

Importing Water from Out of State

Constructing an undersea pipeline, towing water in giant nylon bags, shipping water by tanker, and towing icebergs have all been suggested to help augment California's water supply by importing water from out of state.

The idea of constructing an undersea pipeline to carry fresh water from Alaska to California was studied three decades ago and was last revisited in 1991. As proposed, a 2,600 mile-long suboceanic pipeline would be constructed along the coastline. The pipeline would be sized to carry about 3 maf/yr of Alaskan water from the Stikine and/or Copper Rivers, and would terminate either at Shasta Lake or in Southern California. A preliminary study estimated that the project would cost between $110 and $150 billion and take at least 15 years to complete. A feasibility study by the Congressional Office of Technology Assessment concluded that huge costs and unanswered engineering problems made the idea of building an undersea pipeline unrealistic.

A proposal to fill giant floating nylon bags with water and tow them from Alaska to California had been suggested in the past. During the height of the most recent California drought, a California company sought investors to finance a test run. The water would be filtered, chlorinated, and then loaded into floating bags (the bags float because fresh water is lighter than salt water). An ocean-going tugboat would tow the bags (each holding about 220 af) along the coast. This proposal did not go forward. In 1996, a privately developed water bag delivery system was tested on a pilot scale when two bags of 2.4 af each were towed from Port Angeles, Washington, to Seattle. Some problems emerged in the test run. If implemented at a full scale, costs associated with this option would include towing, constructing, operating, and maintaining the loading/unloading docks and pumps to transfer the bagged water ashore to local treatment and distribution systems.

Shipping water by tankers appears to be the most feasible of the water importation options suggested. Marine transport is a proven alternative to land-based pipelines in the oil industry. A Canadian company is now arranging to ship water to China via tankers. The company was granted Alaska's first water-export permit in 1996. When shipping facilities and a bottling plant are built, the company will begin shipping 390 af/yr of Alaskan water to China using tankers, retrofitted to food grade cargo. The water is to be bottled in a plant to be built by the company and the Chinese government. The City of San Diego is considering a marine transport demonstration project, where a private company would transport up to 20 taf/yr of water from British Columbia to the City of San Diego using tankers. The demonstration project, if implemented, could provide cost and technical data on bulk tanker shipping of water. The U.S. Ocean Pollution Act of 1990, which required phasing out single-hulled oil tankers, presented an opportunity to make tankers available for conversion into bulk water carriers at reduced costs. Tanker haulage could provide a flexible delivery system for emergency supply of water for coastal areas in the event of earthquakes or droughts.

Gray Water

Some residential wastewater can be directly reused by homeowners as gray water. Gray water can be used in subsurface systems to irrigate lawns, fruit trees, ornamental trees, and shrubs and flowers (in finite amounts, depending on the plant types being irrigated). Water from the bathroom sink, washing machine, bathtub, or shower is generally safe to reuse. Care must be taken so that people and pets do not come in contact with gray water. Food irrigated by gray water subsurface systems should be rinsed and cooked before being eaten.

Gray water has been used by some homeowners in coastal urban areas during extreme drought to save their landscaping. In the past, health concerns and lack of information limited use of gray water. In 1992, the Legislature amended the Water Code to allow gray water systems in residential buildings subject to appropriate standards and with the approval of local jurisdictions. There appears to be limited interest in exploring gray water as an option beyond listing its use as a potential urban BMP.

Watershed Management on National Forest Lands

National forest lands provide about half of the State's runoff. A Department study of vegetation management found that thinning trees and shrubs from 33,000 acres of foothill watershed above Lake Oroville might increase average annual runoff by 2.5 taf. USFS estimates that if national forest management as practiced during the 1980s had been practiced earlier, the average annual runoff from national forests would have been increased by about 360 taf (an increase of about 1 percent). Without new storage facilities, only a fraction of this amount would contribute to water supply.

Forest management proposals prepared on behalf of the biomass power industry call for removing excess dead material and invasive species from the forest understory and thinning of the trees themselves. Tree thinning would produce fuel for the biomass power industry. These proposals attempt to return forests to their pre-fire exclusion condition, achieving wildfire reduction and wildlife and water supply benefits. From a water supply perspective, extensive areas of land would have to be managed to increase statewide water supplies. The maximum rate of forest evapotranspiration is reached at about 65 percent tree and shrub cover density. To achieve water savings, it would be necessary to thin trees and shrubs to reduce cover to less than 65 percent, requiring detailed evaluation of potential environmental impacts. Watershed management would require ongoing treatment of forest vegetation to prevent loss of water yield due to regrowth of trees and shrubs.

Currently, no local water agencies are actively pursuing forest management as a component of their future supply. The potential environmental impacts and institutional difficulties of establishing a forest management program suggest that it would be carried out as part of a multipurpose program whose main objectives would be timber management or fire suppression rather than water supply.

Long-Range Weather Forecasting

Accurate advance weather information—extending weeks, months, and even seasons ahead—would be invaluable for planning all types of water operations. Had it been known, for instance, that 1976 and 1977 were going to be extremely dry years, or that the drought would end in 1977, water operations could have been planned somewhat differently and the impacts of the drought could have been lessened. The response to the 1987-92 drought could have been modified to store more water in the winter of 1986-87 and to use more of the remaining reserves in 1992, the last year of the drought.

The potential benefits of dependable long-range weather forecasts could be calculated in hundreds of millions of dollars, and their value would be national. Hence, research programs to investigate and develop forecasting capability would most appropriately be conducted at the national level. The National Weather Service routinely issues 30 and 90 day forecasts; the Scripps Institution of Oceanography in San Diego (until recently) and Creighton University in Omaha, Nebraska, make experimental forecasts. The predictions have not been sufficiently reliable for water project operation. Predictions may be improved by research on global weather patterns, including the El Niño Southern Oscillation in the eastern Pacific Ocean.

Summary of Statewide Supply Augmentation Options

The preceding sections evaluated statewide water management options, including demand reduction measures and large-scale water supply augmentation measures that would provide supply to multiple beneficiaries. Demand reduction and water recycling options are shown in the regional option tabulations in Chapters 7–9, since these options would be implemented by individual local agencies in their service areas. Table 6-10 summarizes options likely to be implemented by 2020 to meet statewide needs. Because these statewide options would provide new water, the opportunity exists for the options' effectiveness to be multiplied through regional reapplication. Therefore, the options would provide regional applied water gains that are greater than the gains shown in Table 6-10.

CALFED

Statewide options include actions that could be taken by CALFED to develop new water supplies. The water supply yield shown for the CALFED Bay-Delta program's preferred alternative is necessarily a placeholder, as a final program environmental document for the Bay-Delta solution has not been completed. The CALFED placeholder does not address specifics of which upstream of Delta storage facilities might be selected, or how conjunctive use programs might be operated. The placeholder assumes dual Delta conveyance (Alternative 3) and approximately 3 maf of storage facilities, with 1 maf of this storage dedicated for environmental uses. Project yield and operating criteria were defined by a DWRSIM operations study. The CALFED placeholder used for Bulletin 160-98 quantification of potential CALFED new water supply does not include water use efficiency measures proposed in a technical appendix to CALFED's March 1998 draft

TABLE 6-10

Statewide Supply Augmentation Options Likely to be Implemented by 2020[a]

Options	*Potential Gain (taf)*	
	Average	*Drought*
CALFED Bay-Delta Program	100	175
SWP Improvements		
Interim South Delta Program	125	100
Conjunctive Use Programs	—	55
Water Marketing (Drought Water Bank)	—	250
Multipurpose Reservoir Projects		
Auburn Dam	620	370
Friant Dam Enlargement	90	0
Total	**935**	**950**

[a] Demand reduction options are shown in the regional option tabulations in Chapters 7–9. Demand reduction options would be implemented by individual local agencies in their service areas.

PEIS/PEIR, because the CALFED operations studies used to quantify program water supply benefits did not incorporate those demand reductions.

Other Statewide Options

Other likely statewide options include specific projects to improve SWP water supply reliability, water marketing through the Department's DWB, and two multipurpose reservoirs. A third potential multipurpose reservoir option, an enlarged Shasta Lake, was not included as a likely option because further studies are needed to quantify the water supply and flood control benefits associated with different potential reservoir sizes. Preliminary studies suggest that a 9 maf enlargement of Shasta Lake would yield 760 taf in average years and 940 taf in drought years. Additional evaluation of this option is recommended.

The two multipurpose reservoir projects included as statewide options – Auburn Reservoir and enlarged Millerton Lake (Friant Dam)—were included as likely options to recognize the interrelationship between water supply needs and the Central Valley's flood protection needs. It is recognized that both projects may have controversial aspects and that neither of them is inexpensive. However, both projects offer enough benefits to justify serious consideration. The lead time for planning and implementing any large reservoir project is long, and it would take almost to this Bulletin's 2020 planning horizon for the projects to be constructed.

The identity of the specific entity(ies) that might implement the two multipurpose reservoir projects is uncertain. USBR, as the owner of the existing Friant Dam and as the federal agency having authorization for operating Auburn, would presumably be a participant. The implementing entity could be a partnership of some combination of federal/State/local agencies.

Allocating Options Yield Among Hydrologic Regions

In Tables 6-11 and 6-12, yields from likely statewide supply augmentation options were allocated among potentially participating hydrologic regions to illustrate how the supplies might be used. Potential supply from a Friant Dam enlargement was shown as remaining in the San Joaquin River and Tulare Lake Regions, where existing Friant supplies are used. For Auburn Dam and CALFED, supply was divided among hydrologic regions served by CVP and SWP facilities. Auburn could also provide supplies for foothill communities that are too small to develop projects on their own, as discussed in Chapter 8. (In neither option is it assumed that the CVP or SWP would contract for the supply—only that conveyance facilities exist to make the water available to potential users.) The Bulletin makes no attempt to allocate costs of these projects between flood protection and water supply.

Uncertainties in the Bulletin Planning Process

Planning about the future is subject to uncertainty. In response to public comments, this section briefly analyzes the effects of some uncertainties on the shortage forecasts and potential options presented in Bulletin 160-98.

Water use forecasts rely on assumptions about population growth, urban per-capita water use, land use and

TABLE 6-11

Likely Statewide Supply Augmentation Options by Hydrologic Region
2020 Average Year (taf)

Region	*CALFED*	*ISDP*[a]	*Conjunctive Use*[a,b]	*DWB*[b]	*Auburn Dam*	*Friant Dam*	*Total*
North Coast	—	—	—	—	—	—	—
San Francisco Bay	—	8	—	—	—	—	8
Central Coast	2	1	—	—	2	—	5
South Coast	15	68	—	—	67	—	150
Sacramento River	—	—	—	—	85	—	85
San Joaquin River	—	—	—	—	—	39	39
Tulare Lake	70	35	—	—	310	51	466
North Lahontan	—	—	—	—	—	—	—
South Lahontan	12	10	—	—	152	—	174
Colorado River	1	3	—	—	4	—	8
Total	**100**	**125**	**—**	**—**	**620**	**90**	**935**

[a] SWP Improvements

[b] The options provide only drought year supplies

cropping patterns, and environmental water requirements. Environmental water requirements are the most difficult to forecast, as they are driven by regulatory and legislative processes. Implementation of CVPIA and SWRCB's Bay-Delta Plan, new ESA restrictions, and FERC relicensing/electric utility deregulation are actions that could significantly modify forecasted environmental demands with the Bulletin 160-98 planning period.

In addition to forecasting water demand components, the Bulletin must also characterize future water management options. The CALFED Bay-Delta program and the draft CRB 4.4 Plan are still in development. These programs have been represented by placeholder throughout the Bulletin. Even if final decisions on the programs were made in the near future, both are long-term programs that will be implemented in phases; some phases may extend beyond this Bulletin's planning horizon.

To illustrate the effects of uncertainties on the Bulletin's water budgets, maximum and minimum applied water shortages associated with potential implementation of SWRCB's Bay-Delta water rights proceeding and CALFED are shown in Table 6-13. For comparison, the Bulletin's forecasted 2020 applied water shortages are 2.4 maf in average years and 6.2 af in drought years with existing facilities and programs. As discussed in earlier chapters, there are no data available at this time to quantify site-specific impacts of new ESA listings, FERC relicensing, and electric utility deregulation.

TABLE 6-12

Likely Statewide Supply Augmentation Options by Hydrologic Region
2020 Drought Year (taf)

Region	*CALFED*	*ISDP*[a]	*Conjunctive Use*[a]	*DWB*	*Auburn Dam*	*Friant Dam*	*Total*
North Coast	—	—	—	—	—	—	—
San Francisco Bay	—	7	18	75	—	—	100
Central Coast	4	1	—	51	1	—	57
South Coast	26	54	22	3	39	—	144
Sacramento River	—	—	—	—	51	—	51
San Joaquin River	—	—	—	—	—	—	—
Tulare Lake	123	28	—	51	185	—	387
North Lahontan	—	—	—	—	—	—	—
South Lahontan	21	7	15	70	91	—	204
Colorado River	1	3	—	—	3	—	7
Total	**175**	**100**	**55**	**250**	**370**	**—**	**950**

[a] SWP Improvements

Several large-scale environmental restoration programs are just beginning. These programs may entail significant acquisition of agricultural land and its conversion to habitat uses, as well as extensive water acquisition for environmental purposes. It is too soon to be able to quantify their water use impacts; these are among the uncertainties that must be resolved over time.

Bulletin 160-98 assumes SWRCB's Order WR 95-6 as the prevailing Bay-Delta standard, with the CVP and SWP meeting the standards under the terms of the Bay-Delta Accord. The alternatives contained in SWRCB's draft EIR for the water rights proceeding would broaden the responsibility for meeting standards to include additional Central Valley water users. Doing so can entail different flow regimes in Valley and Delta waterways, resulting in changes in water supplies. To capture the effects of uncertainties of SWRCB's water rights proceeding, flow Alternative 5 in SWRCB's draft EIR was used to determine the maximum shortage; flow Alternative 6 was used to compute the minimum shortage. Under flow Alternative 5, Bay-Delta standards would be met through monthly average flow requirements established for each of the major watersheds tributary to the Delta. Under flow Alternative 6, Bay-Delta standards would be met solely by operation of the CVP and SWP. Flow objectives at Vernalis on the San Joaquin River would be met by the CVP through releases from the Delta-Mendota Canal via the Newman Waterway into the San Joaquin River.

Implementation of any of the future water management options discussed in the Bulletin would be subject to completing appropriate environmental documentation and obtaining the required permits and approvals, including compliance with ESA requirements. The Tipton Kangaroo rat, listed as endangered under both ESA and CESA, is an example of a listed species found in parts of the San Joaquin Valley where groundwater conjunctive use projects might be planned.

TABLE 6-13

Effects of Alternative Assumptions on 2020 Applied Water Shortages (taf)

	Applied Water Shortage Range	
Region	***Average***	***Drought***
North Coast	0	194
San Francisco Bay	0-13	276-295
Central Coast	172-176	270-276
South Coast	944-1,053	1,270-1,441
Sacramento River	0-85	739-989
San Joaquin River	63-122	711-769
Tulare Lake	264-1,027	1,619-2,071
North Lahontan	10	128
South Lahontan	270-285	303-325
Colorado River	147-149	157-162
Total (rounded)	**1,870-2,920**	**5,670-6,650**

For CALFED implementation, the Bulletin's placeholder assumes dual Delta conveyance (Alternative 3) and approximately 3 maf of surface water storage facilities. Project yield and operating criteria were defined by an operations study which assumed that 1 maf of new storage would be operated to meet CALFED's ecosystem restoration program targets. The maximum shortage condition results from assuming that no new water supply is provided by CALFED (no storage facilities are constructed). The minimum shortage results from assuming approximately 6 maf of surface and groundwater storage. (CALFED's assumption for this scenario is that 1.25 maf of new storage would be operated to meet ERP targets.)

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Options for Future Environmental Habitat Enhancement

A number of programs designed to restore and/or enhance environmental resources are in various stages of implementation. These programs vary in scope, geographic region, and objective. Some of these programs provide environmental water supplies; others involve structural measures, such as placing spawning gravel or constructing fish screens. Some of these programs are legislatively driven; others have resulted from collaborative efforts among stakeholders. Table 6-14 illustrates the emphasis now being placed on environmental restoration actions, by identifying a variety of funding sources available for fishery-related environmental restoration actions.

This section identifies and describes programs expected to provide future environmental benefits. This section covers a representative sample, and is not meant to be a comprehensive listing of all possibilities statewide.

Central Valley Project Improvement Act

Some CVPIA environmental restoration actions, such as water acquisition and fish screening, are applicable to the entire Central Valley. Site-specific projects, such as construction of the Shasta Dam TCD, are described in Chapters 7–9.

The May 1997 draft Anadromous Fish Restoration Plan proposed habitat restoration actions such as spawning gravel placement and stream channel restoration, acquisition of land for wildlife habitat, construction of fish screens and facilities to improve passage of migrating anadromous fish, and development of plans to prevent habitat degradation due to sedimentation and urbanization. The plan also included target instream flows for rivers and streams in the Central Valley and the Delta. The three tools available for USBR to meet these flow objectives are reoperation of the CVP, dedication and management of 800 taf of CVP yield annually, and water acquisition. Water acquisition efforts were described in the water marketing section of this chapter. Tools available to meet CVPIA's broad goal of doubling anadromous fish populations in the Central Valley include the many physical habitat restoration actions specified in the act, as well as substantial funding from the CVPIA Restoration Fund and from general congressional appropriations.

USBR and USFWS have contributed funding for local agency and privately owned fish screen installation projects and planning studies as part of the anadromous fish screening program. About 20 grants have been executed to date for screening projects and feasibility studies of screening alternatives. Examples of completed and pending projects are described in Chapter 5. USBR and USFWS have completed two spawning gravel replenishment projects on the Sacramento River below Keswick Dam. Additional projects are being planned for the other rivers authorized in the act. The gravel replenishment actions are analo-

Restoring and enhancing riparian habitat helps sustain healthy populations of the species that rely on this habitat. Beavers are an example of a species dependent on riparian habitat.

TABLE 6-14

Environmental Restoration Funding

Program and Responsible Agencies	*Projects/Program Funded Selection Criteria*	*Authorizing Legislation or Agreement*	*Funding Source*	*Funding Allocation*
Program: CVPIA Anadromous Fish Restoration Program **Responsible Agencies:** USBR and USFWS	**Projects/Program Funded:** This program funds environmental restoration actions contributing to the goal of doubling natural production of anadromous fish in Central Valley rivers and streams. The program gives first priority to measures which protect and restore natural channel and riparian habitat values through habitat restoration actions; augment river and stream flows; and implement supporting measures mandated by CVPIA Section 3406(b). **Selection Criteria:** None specified in statute.	CVPIA	Congressional appropriations from CVPIA Restoration Fund and Energy and Water Development Fund	Varies (actual expenditures: federal FY 1995, $0.8 million; FY 1996 $1.4 million)
Program: CVPIA (State cost-sharing program) **Responsible Agencies:** DWR and DFG, in coordination with USBR and USFWS	**Projects/Program Funded:** This program funds environmental restoration projects with mandatory State cost-sharing under CVPIA Section 3406. Projects include the Shasta Dam temperature control device, Red Bluff Diversion Dam fish passage actions, spawning gravel restoration projects, and fish screens. **Selection Criteria:** Projects must be capital outlay actions with mandatory State cost-sharing under CVPIA. California and the United States have executed a master cost-sharing agreement covering crediting and transferring funds for the restoration actions.	CVPIA Proposition 204 1994 State-federal cost-sharing agreement	General obligation bonds	$93 million
Program: Category III Program **Responsible Agencies:** CALFED agencies	**Projects/Programs Funded:** Nonflow related projects to protect and improve Bay-Delta ecological resources. **Selection Criteria:** Selection is based on RFP process.	Bay-Delta Accord	Proposition 204, local water agency contributions, congressional appropriations	Proposition 204 provided $60 million for State contribution.

TABLE 6-14

Environmental Restoration Funding (continued)

Program and Responsible Agencies	*Projects/Program Funded Selection Criteria*	*Authorizing Legislation or Agreement*	*Funding Source*	*Funding Allocation*
Program: CALFED Ecosystem Restoration Program **Responsible Agencies:** CALFED agencies	**Projects/Program Funded:** To be determined, but could include fish screens, spawning gravel restoration projects, and riparian habitat enhancement projects. The funds are not available until an EIR/EIS and a State-federal cost-sharing agreement are completed. **Selection Criteria:** To be determined.	Proposition 204	General obligation bonds	$390 million
Program: Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement) **Responsible Agencies:** DWR and DFG	**Projects/Program Funded:** Fish screens, rearing striped bass, gravel restoration projects, hatchery and other actions to benefit aquatic resources, particularly salmon and striped bass. Geographic scope includes the Central Valley and the Delta. **Selection Criteria:** Actions that benefit aquatic resources, particularly chinook salmon, steelhead, and striped bass. Priority will be given to measures on the San Joaquin River system. The Department and DFG staff review project proposals and submit them to an advisory committee composed of representatives from SWP contractors and the environmental and fishing communities. Recommendations are presented to the directors of the Department and DFG for approval.	Agreement between the Department and DFG to offset direct fish losses in relation to Banks Pumping Plant, dated December 1986	SWP funds administered by the Department	$15 million for fish population recovery program, and additional annual funding to compensate for annual fish losses caused by the Banks Pumping Plant[a]
Program: Tracy Fish Agreement **Responsible Agencies:** USBR and DFG	**Projects/Program Funded:** This agreement between DFG and USBR implements measures to reduce, offset, or replace direct losses of chinook salmon and striped bass in the Delta as a result of Tracy Pumping Plant diversions. **Selection Criteria:** A committee composed of representatives from USBR, DFG, and USFWS screens project proposals. Projects are funded upon recommendation by DFG Director to USBR.	Tracy Fish Agreement between USBR and DFG, dated June 1992	Congressional appropriations for operations and maintenance of CVP, administered by USBR	Approximately $1 million per year. USBR has provided funding totaling $6.5 million during 1992-97

TABLE 6-14

Environmental Restoration Funding (continued)

Program and Responsible Agencies	*Projects/Program Funded Selection Criteria*	*Authorizing Legislation or Agreement*	*Funding Source*	*Funding Allocation*
Program: Commercial Salmon Stamp Account **Responsible Agency:** DFG	**Projects/Program Funded:** Projects to restore salmon populations through habitat restoration and breeding, and projects which provide public education on the importance and biology of salmon. Examples of eligible restoration projects include spawning gravel restoration, bank stabilization, riparian revegetation, fish passage improvement, installation of fish ladders and screens, and short-term salmon breeding. **Selection Criteria:** Projects are evaluated based on benefits to fishery resources, need for work in a particular watershed for target species, and project costs. Project proposals are evaluated and prioritized first by DFG. Projects for salmon habitat restoration and breeding are sent to the Commercial Salmon Trollers Advisory Committee. There are two subaccounts in the program—a commercial salmon stamp dedicated account, and an augmented salmon stamp dedicated account. The commercial salmon stamp dedicated account is statutorily directed to salmon breeding. Expenditures from the other account must meet the recommendations of the advisory committee. Final funding decision is by the Director of DFG.	Fish and Game Code Sections 7860-7863 that impose a stamp fee on commercial salmon fishers, as well as commercial passenger salmon fishing vessel operators	Annual stamp fee which ranges from $85 to $260 depending on salmon landing	Total annual revenue varies from $340,000 to just over $1 million.
Program: California Wildlife, Coastal and Park Land Conservation Initiative (Proposition 70) **Responsible Agency:** DFG	**Projects/Program Funded:** Projects to restore and enhance salmon streams, and wild trout and native steelhead habitat. **Selection Criteria:** Similar to salmon stamp program. Project proposals are initially reviewed by DFG and then sent to the Commercial Salmon Trollers Advisory Committee and to the Proposition 70 subcommittee (a six-member group representing the Commercial Salmon Trollers Advisory Committee and the California Advisory Committee on Salmon and Steelhead Trout) for funding consideration. Final approval for funding is by the Director of DFG.	Proposition 70 of 1988[b]	General obligation bonds	see footnote

[a] Generally, the $15 million funds projects with long-term benefits to fish, while the annual account funds projects to replace fish lost annually at the pumping plant. By 1996, the Department had allocated all of the $15 million and had spent about $6 million in annual mitigation projects.

[b] State FY 1997-98 was the last year of funding under Proposition 70. DFG received $10 million to restore and enhance salmon streams, and $6 million to restore and enhance wild trout and native steelhead habitat and related projects.

gous to an operations and maintenance program, where work would be done periodically on river segments identified as needing more gravel. A monitoring program would be required, both to identify areas that are gravel-limited and to evaluate the effectiveness of the gravel provided.

Category III Program

The Category III funding program was established as part of the 1994 Bay-Delta Accord to address non-flow factors affecting the health of the Bay-Delta ecosystem. A steering committee of agricultural, urban, and environmental stakeholders administered the project selection process

TABLE 6-15

Sample Projects Funded by Category III Program

Project / Program	*Proponent*	*Category III Funds*
Battle Creek Restoration	DFG	$730,000
Durham Mutual Fish Screen and Fish Ladder	Durham Mutual Water Company	up to $416,500
M&T/Parrott Pump Relocation and Fish Screen	Ducks Unlimited, Inc.	$1,550,000
Biologically Integrated Orchard Systems Program	Comm. Alliance w/ Family Farmers Fnd.	$660,000
Sacramento R. Habitat Restoration (Colusa to Verona)	Wildlife Conservation Board	$400,000
Suisun Marsh Screening Project	Suisun Resource Conservation Dist.	up to $950,000
Sacramento River Winter-Run Broodstock Program	Pacific Coast Fed. of Fishermen's Assoc.	$300,000
Western Canal Water District Butte Creek Siphon	WCWD	$2,739,000
Prospect Island Restoration	DWR	up to $2,535,000
Sacramento R. Habitat Restoration (Verona to Collinsville)	DWR/The Reclamation Board	$500,000
Princeton Pumping Plant Fish Screens	Reclamation District 1004	$75,000
Princeton-Codora-Glenn/Provident ID Fish Screen	PCGID/PID	$5,575,000
Cosumnes River Preserve (Valensin Acquisition)	The Nature Conservancy	$1,500,000
Lower Butte Creek Habitat Restoration	The Nature Conservancy	$130,000
Sherman Island Levee Habitat Demonstration	DWR	up to $480,000
Ecological Functions of Restored Wetlands in the Delta	University of Washington	$475,000
Molecular Genetic Identification of Chinook Salmon Runs, Focused on Spring-Run Integrity	Bodega Marine Laboratory	$450,000
Decker Island Tidal Wetland Enhancement	Port of Sacramento	$399,000
Yolo Bypass Habitat Restoration Study	DFG	$226,000
Clear Creek Property Acquisition Assistance	BLM	up to $211,000
Research Program to Address the Introduction of Non-Indigenous Aquatic Species	San Francisco Estuary Institute	$197,000
Sacramento River and Major Tributaries Corridor Mapping	Calif. State University, Chico	$145,200
Fish Screen for Unscreened Diversion on Yuba R.	Browns Valley Irrigation District	$114,750
Effects of Toxics on Central Valley Chinook Salmon	Fox Environmental Management	$110,000
Barrier Intake Screen at Wilkins Slough Diversions	Reclamation District 108	$100,000
San Joaquin River Main Lift Canal Intake Channel Fish Screen Facility	Banta-Carbona Irrigation District	$100,000
Adams Dam Fish Screen and Fish Ladder	Rancho Esquon Partners	up to $100,000
Gorrill Dam Fish Screen and Fish Ladder	Gorrill Land Company	up to $100,000
Fish Screen Testing for Small Unscreened Diversions	Buell and Associates	$90,000
Watershed Management Strategy for Butte Creek	Calif. State University, Chico	$83,000
Establish Battle Creek Watershed Conservancy	Western Shasta Resource Consv. Dist.	$50,000
Inventory of Rearing Habitat for Juvenile Salmon	Calif. State University, Sacramento	$24,500
Total		**$21,515,950**

in 1995 and 1996. During this period, the program funded 32 restoration projects, including land acquisition, fish screening, habitat restoration, and a toxicity study. In 1997, CALFED became the lead agency for implementing the Category III program. Program funding sources include $10 million per year (for 3 years) from water users and $60 million from Proposition 204 funding. The Ecosystem Roundtable, a subcommittee of the Bay-Delta Advisory Council, provides input on selection of Category III projects. Table 6-15 is a sampling of projects funded through 1997. Often, projects that receive part of their funding from the Category III program are also funded in part by CVPIA's AFRP, the 4-Pumps program, or other restoration programs.

The Prospect Island restoration project is an example of a project funded by Category III. Prospect Island, an approximately 1,600-acre tract in the Delta, has a project area of about 1,300 acres in agricultural land use. The project's objectives are to create wetland and shaded riverine aquatic habitat, restore fish and wildlife habitat, and decrease maintenance costs for the Sacramento Deepwater Ship Channel levee. Actions include flooding the interior of the island to create small internal islands, stabilizing existing levees by flattening the slopes, and planting vegetation to provide erosion control. The project is sponsored by USACE (under WRDA Section 1135 authority) and the Department. USBR purchased the project site with CVPIA funds in 1995. After restoration is complete, USFWS will manage the property in conjunction with the nearby Stone Lakes National Wildlife Refuge. Category III has established an endowment fund of $1.25 million for long-term project maintenance.

CALFED Bay-Delta Ecosystem Restoration Program

CALFED's Ecosystem Restoration Program is to provide the foundation for a long-term ecosystem restoration effort that may take several decades to implement. The ERP is included in each of the alternatives being evaluated in the programmatic EIR/EIS. Some proposed actions contained in the plan include:

- Breeching levees for intertidal wetlands.
- Constructing setback levees to increase floodplain and riparian corridors.
- Limiting further subsidence of Delta islands by implementing measures such as restoring wetlands to halt the oxidation of peat soils.
- Controlling introduced species and reducing the probability of additional introductions.
- Acquiring land or water from willing sellers for ecosystem improvements.
- Providing incentives to encourage environmentally friendly agricultural practices.

Congress authorized $430 million over the next three years for the federal share of CALFED programs such as Category III and initial implementation of the ERP, and appropriated $85 million for federal fiscal year 1998. Proposition 204 also included $390 million for implementation of the ERP. This funding will not be available until after CALFED's PEIR/EIS has been completed.

CALFED operations studies, in addition to modeling storage and conveyance elements, also model CALFED's ecosystem restoration common program element through specification of ERP environmental flow targets. In the operations studies, water supplies required to meet ERP flow targets are provided from new storage facilities dedicated to environmental restoration. Water acquisitions from willing sellers are assumed to fully meet flow targets when sufficient flow is unavailable from environmental storage releases.

The ERP outlines several environmental flow objectives to support sustainable populations of plant and animal species in the Bay-Delta. The ERP identifies monthly and 10-day flow event targets for Delta outflow and for many of the river basins within the Bay-Delta watershed. As a simplification, CALFED operations studies focus on flow targets on the Sacramento River at Freeport. (The Freeport flow target is the most significant in terms of total instream flow volume.) Instream flow targets not modeled by the operations studies include: Sacramento River at Knights Landing, Feather River at Gridley, Yuba River at Marysville, American River at Nimbus Dam, Stanislaus River at Goodwin Dam, Tuolumne River at LaGrange, and Merced River at Shaffer Bridge. The additional river flows targeted by the ERP would occur through CVPIA instream flow requirements, releases from new environmental storage created under the CALFED program, and water acquisition from willing sellers.

CALFED operations studies assume that new storage volume is split among the three water using sectors. The placeholder study assumes 3 maf of new surface water storage, with 1 maf dedicated for environmental water uses. Environmental storage is operated to maximize average annual yield by not imposing carryover provisions. Water released from storage to meet ERP flow targets is not diverted at the Delta.

Other Environmental Enhancement Options

SWP's Sherman and Twitchell Islands Wildlife Management Plans

The objective of the management plans is to control subsidence and soil erosion on Twitchell and Sherman Islands, while providing wetland and riparian habitat. The plans also provide recreational opportunities such as walking trails and wildlife viewing. Subsidence would be reduced by minimizing oxidation and erosion of peat soils on the islands and by replacing present agricultural cultivation practices with land use management practices designed to stabilize the soil. Altering land use practices on Twitchell Island could provide up to 3,000 acres of wetland and riparian habitat.

Fish Protection Agreements

USBR and the Department have entered into agreements with DFG to mitigate fish losses at Delta export facilities. Subsequent to execution of USBR's agreement with DFG, CVPIA directed USBR to substantially upgrade Tracy Pumping Plant's fish protection facilities and to construct a new screening facility. Planning studies are now under way for a major upgrade of the existing facility. The Department's 4 Pumps agreement with DFG has funded, or cost-shared in many habitat restoration actions upstream of the Delta, as described previously. Discussions are presently ongoing regarding the possibility of using the remainder of the agreement's capital outlay funds to construct a fish hatchery on the Tuolumne River.

Upper Sacramento River Fisheries and Riparian Habitat Restoration Program

As described in Chapter 2, elements of the 1989 plan prepared under this program were incorporated in CVPIA, or are being considered in forums such as the CALFED program. In 1992, the Resources Agency reconvened the SB 1086 Advisory Council. The council's current charge is two-part: to serve in an advisory capacity to State agencies responsible for actions likely to affect the Upper Sacramento River and adjacent lands, and to complete the council's earlier work on riparian habitat protection and management. The goals for the latter charge include establishing a riparian habitat management area and a governance or management entity for the area. Recommendations are being developed for the boundaries of a riparian habitat conservation area, management objectives by river reach, and the type of governance organization that could most effectively carry out the management plan.

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Financing Local Water Management Options

Implementing and maintaining many of the options discussed in the Bulletin will require a large commitment of funds. When a local agency is confronted with additional expenditures for water management options, it must decide whether the costs of these options will be paid from current or accumulated revenues (pay-as-you-go), or be financed with the proceeds of debt repaid from future revenues. Historically, local water agencies relied on several methods for long-term debt financing, including general obligation bonds, revenue bonds, and assessment bonds. Innovative long-term debt financing strategies, such as bond pools, are being increasingly used.

Financial costs are different from economic costs. Financial costs are the actual expenditures required by a water agency to repay the debt (with interest) incurred to finance the capital costs of an option and to meet operations and maintenance costs. Thus, the objective of financial feasibility studies is to solve cash flow problems. In contrast, economic costs reflect the costs of committing resources needed to construct, operate, and maintain an option for its life, to whomever they may accrue. Economic feasibility studies are used to compare the relative merit of options, to determine the most economically efficient size or configuration of an option, and to allocate costs among beneficiaries. It is possible for options to be financially feasible and economically unjustified, or vice versa. For example, even though an agency can generate the funds to pay for an option, this does not necessarily mean that the option is economically the best of available options. On the other hand, an option may be economically justified but it cannot be financed because of existing debt limitations.

Financial feasibility is becoming an increasingly important consideration in water supply management planning for a number of reasons.

- Future water demands are expected to exceed present supplies. There is thus a need to develop water supply augmentation and demand management programs.
- Compliance with new EPA and DHS drinking water standards is likely to increase capital expenditures by municipal water agencies.
- Some water suppliers have deferred maintenance and/or replacement of aging facilities to the point where increased operation, maintenance, and replacement costs are being incurred.
- Since the 1980s, the federal government has been reducing aid to state and local governments for large-scale water resources projects, a trend which is expected to continue.
- Since the early 1990s, the Legislature has been shifting property tax revenues away from counties and special districts and into the State's general fund.

Sources of Revenues

Whether capital improvements are funded on a pay-as-you-go basis or through debt financing, a water agency must have sufficient revenues to cover capital costs as well as ongoing operation and maintenance costs. The major sources of revenue for publicly-owned systems include water rates charged to customers, property taxes (although use of these has been limited since passage of Proposition 13), and benefit assessments through special improvement districts. (See Chapter 2 for discussion of Proposition 218 and its impacts on assessments.) Because of voter opposition to further tax increases, local governments have increasingly relied upon other revenue sources such as development impact fees from new construction, standby fees, and fees for special services. These alternatives are typically only feasible for agencies with large service areas, so that income from these fees will be significant and reliable. Investor-owned water agencies and mutual water companies are almost exclusively dependent upon water rates to generate revenues. Tables 6-16 and 6-17 show significant sources of revenue for water agencies by type of ownership and by agency size.

Financing Methods

The ability of a public agency to access different financing methods depends upon the enabling legislation under which the agency was formed. Among other things, the enabling legislation will indicate the agency's:

- Authority to issue bonds, the vote required to authorize issuance, and any limitations on the amounts of bonds or on the amount of indebtedness;
- Powers and methods of tax assessments, including whether the assessments are on an ad valorem basis (a tax based on value of property) or are levied according to benefits, and the type of property (land and/or improvements) upon which the assessments may be levied;

TABLE 6-16

Significant Sources of Revenue to Water Agencies by Type of Ownership

Revenue Sources	*Public*	*Investor*	*Mutual*
Water Rates	X	X	X
Property Taxes	X		
Special Improvement District Assessments	X		
Development Impact Fees	X		
Customer Hookup Fees	X		
Special Service Fees	X	X	

TABLE 6-17

Significant Sources of Revenue to Water Agencies by Water Agency Size

Revenue Sources	*Small*	*Intermediate*	*Medium*	*Large*
Water Rates	X	X	X	X
Property Taxes		X	X	X
Special Improvement District Assessments		X	X	X
Development Impact Fees				X
Customer Hookup Fees				X
Special Service Fees				X

- Revenue sources, including charges, rates or tolls for service or commodities, or sales and leases of property; and
- Area over which it can collect taxes and/or sell services or commodities.

Self-Financing

Self-financing is a form of non-debt financing. A water agency can use reserves generated from accumulated revenues and other income to pay for improvements rather than incurring debt. The pay-as-you-go approach generally works best for small or recurring capital expenditures that can be reasonably accommodated in an agency's annual budget. For major capital improvements, a debt financing approach would be more appropriate.

Short-Term Debt Financing

Short-term debt financing typically includes borrowing instruments with maturities of less than 1 year. Short-term borrowing can be used for cash flow borrowing, financing for capital improvements with relatively short lives, and interim financing for long-term capital improvements. Revenue and tax anticipation notes can be used when an agency is experiencing cash flow problems because revenues are occurring unevenly during the fiscal year. Revenue and tax anticipation notes can be used to pay current expenses, with note repayment coming from revenues received later in the fiscal year. Capital items with relatively short lives can be financed through the use of commercial paper—short-term, unsecured promissory notes backed by a line of credit from one or more banks. Short-term financing methods can provide interim financing for the construction of capital improvements which are planned to be financed on a permanent basis at a later date. Examples of interim financing include grant anticipation notes (where the permanent funding could be a grant from another government agency) and bond anticipation notes (where the permanent funding will come through the issuance of long term debt such as bonds).

Conventional Long-Term Debt Financing

Conventional long-term debt financing methods include general obligation bonds, revenue bonds, assessment bonds, and lease or installment sales agreements, all of which are typically used by publicly owned utilities.

General obligation bonds are used to finance improvements benefitting the community as a whole, and are secured by the full faith and credit of the agency. General obligation bonds issued by public water agencies are secured by a pledge of the agency's ad valorem taxing power. Passage of Proposition 13 and its requirement for two-thirds voter approval have limited the ability of agencies to assess additional property taxes which would be needed to fulfill this pledge, reducing the use of these bonds. General obligation bond limits are often established by a water agency's enabling legislation.

Revenue bonds do not require the agency's pledge of full faith and credit. Debt service for these bonds is paid exclusively from a specific revenue source, such as the revenue obtained from the operation of the financed project. Because revenue bonds do not require voter approval, they are now more commonly used than general obligation bonds.

Assessment bonds are issued to finance capital improvements and debt service, are paid through assessments levied upon real property benefitted by such improvements, and are secured by a lien on that property. Under the Mello-Roos Community Facilities Act of 1982, water agencies may establish a community facilities district and levy a special tax upon land within that district. This tax can be used to finance capital improvements (generally distribution systems), new services, or to repay bonds issued for such purposes. Passage of Proposition 218 in 1996 substantially changed the way in which property-related assessments can be imposed by local agencies. In the future, these assessments must be subjected to a vote of the property owners.

Lease or installment revenue bonds have become common as taxpayer resistance and State statutes have limited the taxing and borrowing ability of local agencies, thus reducing use of general obligation bonds. In California, a form of a lease revenue bond is the Certificate of Participation. With a COP, facilities are built or acquired by an agency of the city, and leased to the city, for which the city makes lease payments equal to the principal repayment plus interest. A city, non-profit corporation, or a community redevelopment agency must be used as the intermediary leasing entity, but that agency must give the facilities to the city free and clear without added expense when the indebtedness is repaid.

Innovative Long-term Debt Financing

New long-term debt financing strategies are being developed to assist water agencies in obtaining funding for water system improvements. Bond pools increase access to bond funds for smaller water agencies who might not otherwise be able to obtain funding. Bond pools use a JPA to combine several small bond offerings into a single financial package, minimizing the cost of bond issuance for participating water agencies. The Association of California Water Agencies and the WateReuse Association offer such financial packages.

Privatization occurs when the private sector becomes involved in design, financing, construction, ownership and/or operation of a public facility such as a water system improvement. Privatization can offer advantages. For example, it may provide cheaper or more accessible financing, and it may provide substantial tax advantages to the private sector. Privately arranged financing may be an attractive option when a publicly owned water agency's access to the financial markets is diminished or nonexistent, as is the case for many smaller utilities.

Another potential opportunity for water agencies involves the provision of funds by one agency for water system or on-farm improvements by another agency, in exchange for use of the water conserved. An example is the agreement between MWDSC and IID, where MWDSC is funding IID system improvements in exchange for a 35-year right to use the waters which have been conserved.

Credit Substitution and Enhancement

Although not financing methods, credit substitution and enhancement can assist local agencies in obtaining financing and in lowering the costs of financing. Credit substitution occurs when an agency substitutes its own credit for that of a local agency that is seeking to finance a project. The local agency can improve the quality of its bonds and obtain them at a lower cost. Credit enhancement occurs when an agency guarantees that the debt service obligations will be met, which can be a low-cost and effective way for states to assist local agencies.

TABLE 6-18

Major State and Federal Financial Assistance Programs

Program	*Eligible Projects*	*Administering Agencies*
State		
Safe Drinking Water Bond Laws	Grants/low interest loans for public water system improvements	DWR/DHS
Water Conservation Bond Laws	Low interest loans for water conservation, groundwater recharge, local water supply, and water recycling projects	DWR/SWRCB
Agricultural Drainage Water Management Loan	Low interest loans for agricultural drainage projects	SWRCB
Safe, Clean, Reliable Water Supply Act of 1996 (Proposition 204)	Low interest loans and grants for water conservation, groundwater recharge and water recycling projects	DWR/SWRCB
Federal		
Water and Wastewater Disposal Loans/Grants	Loans and grants to small communities for water and wastewater facilities	Farmers Home Administration
Community Development Block Grants (HUD)	Grants to large communities for water and wastewater facilities	Housing and Urban Development through Department of Housing and Community Development
Small Business Administration Loans	Loans for private water system improvements	Small Business Administration
Federal/State		
Clean Water Act SRF	Low interest loans for water recycling projects	SWRCB
Safe Drinking Water Act SRF	Low interest loans for public water system improvements	DHS

State and Federal Financial Assistance Programs

State and federal financial assistance programs (loans and grants) are available. These programs target varied objectives including safe drinking water, water conservation, water recycling, and water supply development (for example, groundwater recharge projects). Each of these programs has criteria to determine project eligibility and funding. Most of the state and federal programs do not provide funding to investor-owned and mutual companies because this is considered to be adding value to privately owned businesses. The 1996 Safe Drinking Water Act reauthorization may provide about $12 billion from 1997 through 2003 for current and new drinking water programs, including a state revolving fund of $1 billion per year nationally through 2003. Table 6-18 shows some major state and federal financial assistance programs available for water system improvements. Proposition 204 included grants to local agencies for a variety of purposes. For example, the Department is administering two programs to provide loans (and in some cases, grants) to local agencies for water conservation/groundwater recharge facilities ($30 million) and local projects ($25 million). SWRCB is administering loans for water recycling.

Relationship Between Financing and Water Agency Ownership and Size

The types of financing available can vary depending upon the ownership and size of the water agencies. These relationships are discussed below. Table 6-19 summarizes financing methods by type of ownership. Table 6-20 illustrates financing methods typically available to water agencies of different sizes. Table 6-21 summarizes financial assistance programs by ownership type.

Public Water Agencies

In general, public water agencies have access to more financing methods than do investor-owned and mutual water companies. Many financing instruments will be tax-exempt for publicly-owned agencies. The larger public agencies can issue tax-exempt notes and bonds, assess property taxes, issue special assessment bonds, and enter into public/private partnerships to finance capital improvements. A smaller public agency may be unable to secure such financing because either the cost of the method (such as the cost of issuing bonds) or the amount of funds needed to make improvements exceeds the ability of its customers to pay. In these cases, the smaller agencies need to either obtain federal and state assistance, if available, or pursue innovative financing methods. Local public agencies must limit their rates to amounts needed to cover current financing and water costs—they are not allowed to make a profit.

Investor-Owned Water Utilities

Investor-owned utilities can issue equity stock and sell taxable bonds. The California Public Utilities Commission must give authorization prior to the issuance of stocks or bonds by an investor-owned water com-

TABLE 6-19

Financing Methods Available to Water Agencies by Type of Ownership

Method	*Public*	*Investor*	*Mutual*
Self-Financing	X	X	X
Short-Term Financing			
Fixed Rate Notes	X	X[a]	X[a]
Commercial Paper	X	X[a]	X[a]
Floating Rate Demand Notes	X	X[a]	X[a]
Conventional Long-Term Financing			
Equity Shares or Stock		X	X
Bonds (GO and Revenue)	X	X[a]	X[a]
Lease Revenue	X		
Innovative Long-Term Financing			
Bond Pools	X		
Privatization	X		X
Water transfers	X	X	X
Financial Assistance Programs	X	X[b]	X[b]

[a] Taxable instruments.
[b] State and federal loan and grant programs have limited applications for private water agencies.

pany. This method of financing is primarily limited to the larger investor-owned systems. The smaller investor-owned agencies generally do not issue stock and may lack the rate base that would make other financial methods feasible. The CPUC establishes the return on investment that investor-owned utilities are allowed to earn as part of its rate setting authority. Regulated investor-owned utilities are not able to accumulate reserves. Utilities may use short-and long-term taxable bonds and notes.

Mutual Water Companies

A mutual water company is a privately owned company that issues securities in which lot owners are entitled to one share for each lot they own. Mutual water companies have the ability to assess members to raise capital. This does not require approval by either the members or an outside agency. The amount of the assessment may be limited, however, by the ability of the customers to pay. As a requirement of formation of a mutual water company, a sinking fund must be established that provides capital replacement of water facilities at the end of their useful life. Some of the larger mutual companies may be able to use short- and long-term financing instruments such as taxable bonds and notes.

TABLE 6-20

Financing Methods Typically Available to Water Agencies by Water Agency Size

Method	*Small*	*Intermediate*	*Medium*	*Large*
Self-Financing			X	X
Short-Term Financing				
Fixed Rate Notes				X
Commercial Paper				X
Floating Rate Demand Notes				X
Conventional Long-Term Financing				
Equity Shares or Stock			X	X
Bonds (GO and Revenue)				X
Lease Revenue Bonds				X
Innovative Long-Term Financing				
Bond Pools	X	X	X	X
Privatization	X	X	X	X
Water Transfers	X	X	X	X
Financial Assistance Programs	X[a]	X[a]	X[a]	X[a]

[a] State and federal loan and grant programs have limited applications for private water agencies.

TABLE 6-21

Financial Assistance Programs Available to Water Agencies by Type of Ownership

Programs	*Public*	*Investor*	*Mutual*
State			
Safe Drinking Water Bond Laws	X	X[a]	X[a]
Water Conservation Bond Laws	X		
Agricultural Drainage Water Management Loans	X		
Community Development Block Grants	X		
State Revolving Fund for Wastewater	X		
State Revolving Fund for Drinking Water	X	X	X
Federal			
Water and Wastewater Disposal Loans and Grants	X		X
Community Development Block Grants	X		
Small Business Administration Loans		X	

[a] Loans only; grants not provided to privately-owned agencies.